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OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS AND LETTERS

VOL. XLVIII

NATURAE SPECIES RATIOQUE

MADISON, WISCONSIN
1959

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The *Transactions* welcomes sound original articles in the sciences, arts, and letters. The author or one of the co-authors of a submitted paper must be a member of the Academy. Manuscripts should be typewritten double-spaced throughout, including footnotes, quotations, and bibliographical references. The address to which galley proofs are to be sent should be typed in the upper left-hand corner of the first page. They should be mailed flat or rolled, never folded. Manuscripts should be addressed to Stanley D. Beck, 105 King Hall, University of Wisconsin, Madison 6. Papers received prior to July 31, 1960 will be considered for inclusion in the *Transactions*, volume 49.

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NATURALISTS, BIOLOGISTS, AND PEOPLE[1]

ROBERT J. DICKE
President, Wisconsin Academy of Sciences, Arts and Letters, May 3, 1958 to May 2, 1959

On this occasion, I would like to speak as a practical biologist, and discuss a problem with which you are all well acquainted. It is my intention, however, to pursue a line of thinking that is—quite purposely— different from that usually encountered.

Whenever chemicals are applied to non-crop areas on a broad scale in order to control weeds, or insects, or any form of wildlife, a considerable body of writing concerning it will shortly appear in the popular press and in semi-technical magazines and journals. This is especially true where forest lands, recreational sites, and residential areas are involved. Usually the writing is of a negative nature, and generally critical of the whole operation at least as the purposes and procedures were observed by the writer or as they were brought to his attention. Although the individual popularizer may be a perfectly sincere writer, very often his criticism of the economic biologist may be unfounded or extremely biased. He then succeeds in expanding an alarming body of public misunderstanding.

Now, before going into more detail on this problem, it would be well that I explain the title of my presentation—NATURALISTS, BIOLOGISTS, AND PEOPLE. Some explanation and definition of terms is required, lest I unintentionally imply that naturalists are those who write articles that unjustly criticize professional biologist, using the popular press as their podium. Naturalists are not necessarily such persons. All kinds of individuals may write popular articles. Some are professional writers who may, or may not, be wildlife enthusiasts. These professionals are keenly aware of the angles of a story that will have popular appeal. Other such writers are professional biologists who should know better than to draw preliminary conclusions from inadequate experimental data and then to publicize them. Still another type of writer is the hobbiest who may attempt to write against a background of information that has not been adequately explored and developed.

Let us now define—roughly—those groups of people that I have referred to as naturalists, biologists, and people.

---

[1] Retiring Presidential Address, delivered at the 89th Annual Academy Meeting on May 2, 1959, at Platteville, Wisconsin.

Naturalists are students of natural history, whose interests are primarily observational, and for whom nature is an avocational pursuit or hobby. Make no mistake; I do not use this term lightly, because I feel that I am also a naturalist. I can use myself as a prime example of a naturalist, for I have an abiding love for forest and prairie in their every aspect. We own a cabin and 40 acres of woodland on the Chippewa river. Mrs. Dicke would probably tell you that I must be a very romantic naturalist to love that terribly underprivileged land. Certainly, it is not the fishing or the hunting that draws me there. Neither can it be the pine planting that averages only about an inch of growth per year.

Biologists are professional botanists and zoologists. As scientists, their interests in nature are experimental or technically descriptive. The *economic biologist* has the additional task of managing wildlife—nature, that is—to meet a multiplicity of public demands that range all the way from the protection and propagation of certain plant and animal species to the demand that efforts be made to drastically reduce or eradicate certain species. The drastic decimation of a species population must be by whatever means available, and this often necessarily includes the use of chemicals.

Since much of my professional life has been as an economic entomologist, I can fully appreciate the aims and problems of the economic biologist. Again, using myself as an example, I find that I may be a bit vague and a little romantic in my thinking about nature in connection with my cabin and woods. But in my thinking as a biologist, I must operate within clearly defined experimental boundaries. As an economic biologist, I must also be highly practical in my thinking, planning, and in my working standards.

People make up the last part of our triumvirate of naturalists, biologists, and people. People are all of the so many individuals who are neither naturalists nor biologists. These people not only pay taxes and vote, but they also have an interest and a vital stake in what is going on in the country and in how our natural resources are being used.

Now, these three groups are not sharply defined, by any means. They are, however, representative of the extremes in concepts and special interests that are given expression whenever a wildlife control problem comes to public attention.

Not for the purpose of argumentation, but in the interests of presenting all sides of the problem, let us now examine some rather controversial ideas concerning nature and its control.

Balance of Nature. This is a rather vague idea that is freely expressed by naturalists and people. Apparently it is based on the assumption that at one time all of the wildlife in this country was

in perfect biological harmony—some kind of biological utopia prevailed. Then man entered the picture and, of course, spoiled all this by his intrusion and intervention. He selfishly wanted nature to conform to his way of life. One of my most ardent nature-loving students once expressed it in this way. No doubt, I shocked him when I asked if this was really so bad. In effect, all other species have been trying to do the same thing; man has just been more successful. It is so very difficult to be practical about such an idea—this vague notion that if we could but balance nature again, all of our ills would be corrected. Some purely practical problems arise, such as:

How much hedge row, wood lot, and so on would be required on a farm to balance up 200 solid acres of wheat, or corn?

How many birds would we need to check a flight of pest mosquitoes or a flight of lake flies concentrating on the shoreline of Lake Winnebago? There is little doubt but that they were there in even greater numbers during the "good old balanced nature days."

These and hundreds of other similar practical problems cast some doubt on the practicability of the "balanced nature" idea.

Specific Land Use. As our population increases, land and water must be efficiently managed for specific, not general, uses. It is wishful thinking to believe that all land can be made to serve all purposes without there being some very sharp conflicts. Industrial, agricultural, recreational, residential, natural history study areas, and natural preserves all differ in their requirements for land and wildlife management. We can hope for a harmonious co-existence of these land areas, but management for a specific use will, in all cases, be necessary. Even natural preserves and study areas will not remain in that state for very long without fire, disease, and insect control. This means that in the maintenance of such areas, there will continue to be a need for give-and-take, understanding, and practical thinking by naturalists, biologists, and all people.

It is sometimes necessary that wildlife populations be curtailed sharply. We may wax sentimental about the passing of the prairie, the buffalo, and the passenger pigeon, and we may decry their passing as the result of human greed. But it is not quite as simple as that. The prairie had to be made over into agricultural land to feed the people of the nation. The coexistence of dominant species, including man, is an exceeding difficult relationship to preserve and maintain.

There are many examples of how it is necessary to change the natural state in the interest of specific land uses. A farm fencerow, for instance, or a roadside hedgerow is ideal for the protection and propagation of small game. Of course, this interests the wildlife enthusiasts and the hunters. However, the birds and mammals that

find a haven there may be quite destructive to farmers' crops. Robins and rabbits cannot be condoned in modern fruit culture. And even where such animals can be tolerated, hedgerows are well suited for the propagation of destructive insects, such as grasshoppers and army worms.

Certainly there is going to be an ever increasing need for recreational areas, but within land designated for this use, certain animals and plants will inevitably be eliminated. Someone is certain to pick that last lady slipper. Its only chance of survival will be in a strictly supervised study area or preserve. Nuisance insects (mosquito and fly) and plants (poison ivy) must be eliminated—and with them, perhaps other species as well.

In residential areas, even less refuge for wild species is to be expected. One of the current controversies concerns the apparent conflict between Dutch elm disease control and the protection of robin populations. Perhaps some better control than DDT sprays will be developed. But for the present, we seem to be confronted by two choices: (1) Do not protect elm trees that would require more than 50 years to replace, should they die of Dutch elm disease; or (2) risk a partial decimation of robin populations existing within the disease control area. Personally, I would not care to be the economic biologist in my community who gambled in the robin's favor and lost the trees.

Wildlife Enthusiasts. I am always amazed by the great numbers of people who have little or no interest in wildlife. Most people enjoy having birds around, but they are not very specific about them. Rabbits and squirrels are interesting little creatures to have about the neighborhood, but only as long as the rabbits do not take a fancy to one's flower sets, and as long as the squirrels do not take up residence in an attic or a chimney. And a great many people understandably like dogs, and cats, and children, but all of these little creatures are dynamically opposed to urban wildlife in any form. Most people are interested in lakes and woodlots. They enjoy picnics and family play outdoors in the sun. They want a pleasant vacation outdoors. But, they are not rugged woodsmen, and these interests preclude large populations of mosquitoes, snakes, poison ivy, etc. It would be but small consolation to them that these animals and plants represent the "complete nature". There is very little hope that they may be convinced that these things need to be saved.

Popular Writing. Much has appeared in the popular press concerning the effects of chemicals on wildlife—and on human health, for that matter. I would judge that most of these writers are sincere and honest *within the limits of their knowledge of the subject.* It is, however, at this point that we must be the most careful and discriminating. The articles we read are no more valid than was

the author's knowledge of his subject, or his intent in writing the article. We caution our biology students to read everything they can on a particular subject—but not to believe everything they read. There are many excellent scientific publications concerned with the effects of pesticide chemicals on wildlife. Of course, they are not written in a popular or spectacular vein.

Meaningful biological research is necessarily complex and time-consuming. This fact, however, never justifies any shortcut to conclusions drawn on *accelerated inference* or *coincidence*. What is an *accelerated inference?* It is best illustrated by examples. If X number of a hardy, common bird—such as the robin—is killed by a spray application, what an alarming toll must have been taken among less hardy and less conspicuous bird species! Or, if X robins were destroyed by a single spray application, it will not be long before they become extinct, like the passenger pigeon. In these cases, a spectacular and alarming point is made, even though the biology of the different bird species is hardly comparable.

How does *coincidence* figure in this picture? "A bird was picked up two weeks after spraying, and it showed typical symptoms of DDT poisoning." The possibility of simple brain concussion is not taken into consideration. "We found dozens of dead birds." Last spring, my daughter brought me quite a number of excellent specimens of dead cedar waxwings and finches. But there had been no spraying in the area. Bird mortality is naturally high, especially in the spring. For a two-brooded bird, such as the robin, a natural high mortality is a necessity—otherwise they, too, might become a problem to the economic biologist.

Specialists. Sometimes it must seem to the economic biologist that everyone considers himself a specialist. I believe that most economic biologists have a competent command of their specialty, and a good understanding of the problems they face. It is never their intention to poison the land or endanger the nation's wildlife. Most of them would be pleased to discuss control and preservation problems with interested citizen's groups.

I am greatly impressed—as the general public should also be—with the regulatory checks and precautions that operate in favor of the wildlife enthusiasts. The U. S. Food and Drug Administration are vigilant in their protection of foodstuffs from unwanted contamination by deleterious and doubtful chemicals. The U. S. Department of Agriculture requires label approval of all pesticide chemicals. They guard against dangerous or fraudulent use of control chemicals. The Wisconsin Economic Poisons Law is a state safeguard, under which I, or any other economic biologist, must register my intentions for experiments in mosquito control or any control work. The Wisconsin Committee on Water Pollution must

sanction all lake and stream treatments before they may be undertaken. To these several regulatory agencies, we must add the public consulting organizations, such as the U. S. Public Health Service, State Conservation Departments, and agricultural experiment stations in land-grant colleges.

Pesticides are no longer simply compounded and sold. In these days an industrial firm must spend $1,200,000 on the average, in the development of an acceptable chemical for public use. Most of this sum is spent to establish the products proper and safe usage. Even so, it may have to be recalled immediately because of some unforeseen hazard.

In this discussion, I have attempted to present the problem of species control from a different slant than is usually taken. I have attempted to establish for amateur and professional biologist alike (1) the necessity of species control; (2) an appreciation of the complexity of the problems faced by the economic biologist; (3) that popular criticism should be examined somewhat more dispassionately and carefully; and (4) that there are far more safeguards for human health and wildlife protection than an alarmed public has been led to believe.

SCIENCES

TIMBER YIELDS, WOOD INCREMENT, AND COMPOSITION OF REGENERATION IN A MANAGED HARDWOOD FOREST ON MORAINAL SOILS*

HAROLD F. SCHOLZ[1] and FRED B. TRENK[2]
University of Wisconsin, Madison

The kettle moraine, an interlobate accumulation between the Green Bay and Lake Michigan lobes of the continental glacier (*3*),[3] is characterized by a residual forest cover in which northern red oak (*Quercus rubra* L.), white oak (*Q. alba* L.), black oak (*Q. velutina* Lam.), sugar maple (*Acer saccharum* Marsh.), white ash (*Fraxinus americana* L.), American elm (*Ulmus americana* L.), and basswood (*Tilia americana* L.) constitute the most common trees and likewise those of greatest economic value. Land settlement in the counties traversed by the kettle moraine (Fond du Lac, Dodge, Washington, Jefferson, Waukesha, and Walworth) began in the late 1830's and was virtually complete by 1860. Much of this area has remained wooded because the characteristically short, steep slopes and extremely stony soil, especially in or near the "kettles," make the land unfit for cultivation. Throughout the better part of a century, these forested slopes have been the source of a substantial volume of lumber and rough wood used locally in constructing homes and farm buildings and for fuelwood, fence posts, etc. Uneven-aged stands have resulted from intermittent logging.

For a number of years, the Wisconsin Conservation Department has been acquiring some of the more rugged and better forested areas of the moraines for a State forest. Among the earliest purchases are two tracts, one of 17 acres, the other of 48 acres, located 1½ miles west of the village of Dundee, in Fond du Lac County. Through a cooperative agreement between the Conservation Department; the Agricultural Extension Service, College of Agriculture; and the Lake States Forest Experiment Station, these two tracts were designated as a forest demonstration and research area in 1946 and named the Dundee Timber Harvest Forest.

In the 17-acre tract, located about ¼ mile northeast of the larger unit (Fig. 1) (*6*), red oak is only slightly less abundant than sugar

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* Paper read at the 89th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

[1] Forester, Lake States Forest Experiment Station, maintained at St. Paul 1, Minn., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Minnesota.

[2] State Extension Forester, University of Wisconsin, Madison 6, Wis.

[3] Underscored (italicized) numbers refer to literature citations listed at the end of the paper.

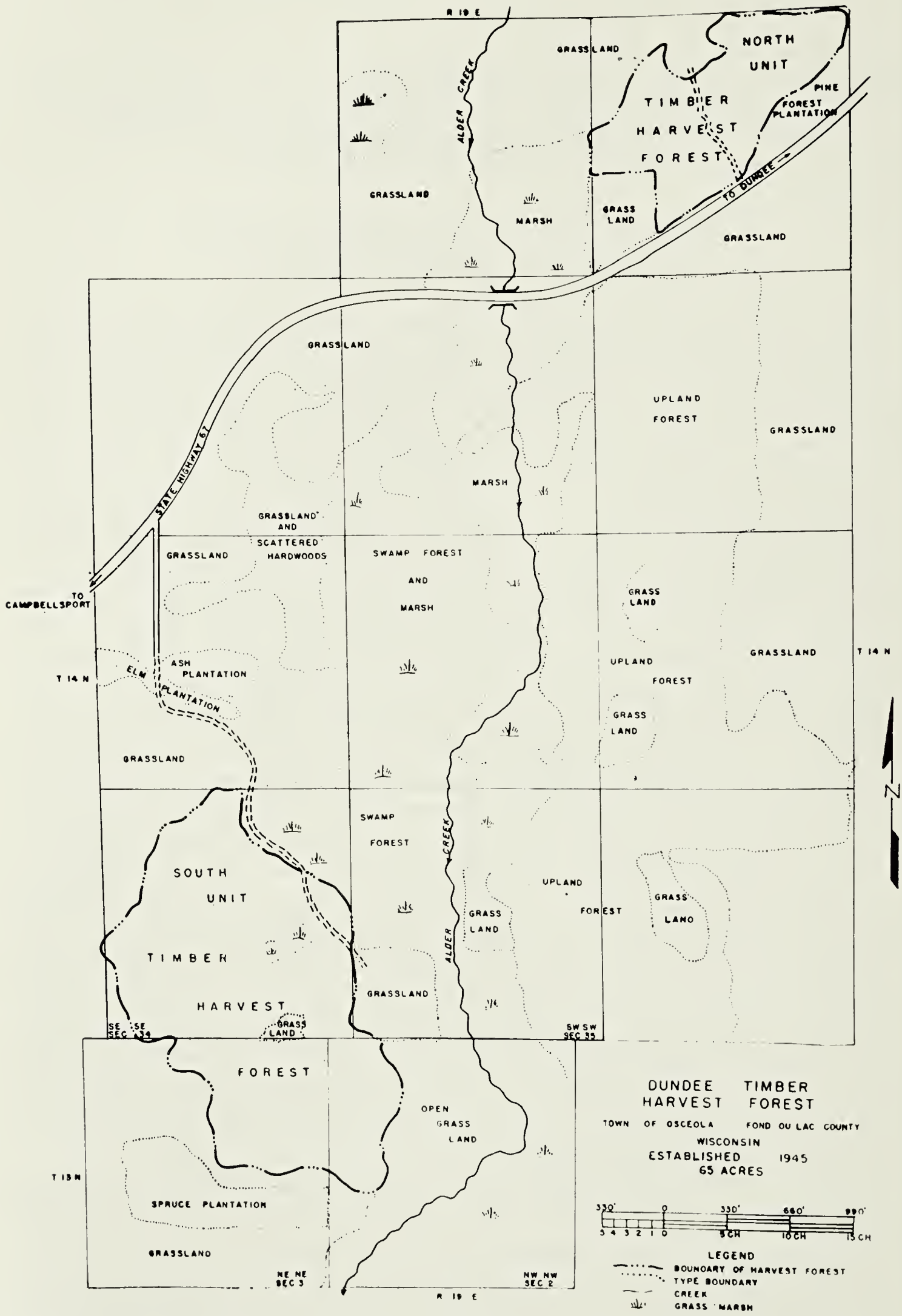

FIGURE 1. Although the two units of the Dundee Woods are approximately a mile apart, both of them can be seen from State Highway 67 and are accessible throughout the year from this all-weather road.

maple but, because of the vigorous seeding of the latter species, the unit offered an attractive opportunity to study the regeneration complex in a situation where a highly tolerant, but notably slower growing tree, the sugar maple, competed with the less tolerant but relatively fast growing northern red oak. In the larger unit, this oak is the most abundant tree in volume of timber and in numbers, with white oak, sugar maple, and basswood providing scattered competition.

This demonstration-research forest has been under intensive management by the three cooperating public agencies since 1946.

Objectives of Management

Factors that must be considered in determining objectives of management are: (1) the size, quality, and composition of the stand; (2) accessibility of the tract and ease with which it can be logged; (3) current and possible future demands for specific forest products; and (4) the character and reliability of market outlets within trucking distances of the property.

A preliminary examination of the Dundee Forest in the summer of 1946 showed that it was fairly well stocked with saplings, poles, and small-to-medium-sized sawtimber averaging about 90 years in age. There also appeared to be enough diversity in composition, size, and quality of the growing stock, and sufficient total gross volume to ensure a workable annual or periodic cut of saw logs and cordwood products.

Logs of lumber and veneer grades are in fair to good demand in this part of the State, but the market for tie bolts and rough wood products is poor. Since high-quality products will be the ultimate goal, it seemed logical to concentrate on ridding the stand of as many undesirable stems as possible during the first cutting cycle. Consequently, this type of program was set up as a definite silvicultural objective, although its possible adverse effect on the initial income from the tract was fully appreciated.

Inventory of the Growing Stock

A 100-percent cruise was made of the sawtimber stand on both units of the Dundee Forest in the fall of 1946. This intensive coverage was necessary because the two tracts were to be used for various research studies as well as for demonstration purposes. A less precise inventory is required, of course, for the average farm-woodland management plan.

Trees less than sawtimber size were not tallied in this initial cruise because there was little actual or potential market for cordwood material at the time. Northern red oak, amounting to about

46 percent of the total gross board-foot volume, is the most important timber species on the area.

Species	Percent of Total Board-foot Volume
Northern red oak	46.1
Sugar maple	24.4
American basswood	8.3
Elm (slippery and American)	11.2
White and bur oaks	5.3
White ash and others	4.7
Total	100.0

Estimating the Allowable Cut

A rate of timber depletion which is offset or exceeded by growth of the residual stand represents the basis of an allowable annual or periodic cut for small parcels of timber. This does not mean that every farm woodland can be cut indefinitely on a sustained-yield basis. Some forest types are ecologically adapted to such silvicultural treatment while others are not. The Dundee Woods falls into the latter category because of the preponderance of more or less even-aged oak on the tract.

The method used to estimate the allowable cut in this case was based on two assumptions: (1) that the main sawtimber stand can be carried to a maximum age of 150 to 160 years, and (2) that the mean annual increment, plus ingrowth of cordwood trees to sawtimber size, will be at least 2½ percent of the total gross board-foot volume remaining after each harvest.

Gauging the Progress of Forest Management

It was impracticable to make a 100-percent cruise of the forest after each harvest. An alternate system of "bookkeeping" was employed to determine how much of the total volume was in sawtimber trees as compared to that in cordwood-sized stems, how much new wood was being added currently by growth, and how silvicultural practices affected the amount, species, and ultimate survival of natural regeneration. To obtain this information, 34 circular, ⅕-acre permanent sample plots were established in September 1947. This fairly intensive sample was justified on the grounds that more accurate "controls" are needed on a demonstration-research area than elsewhere.

Every sawtimber tree within the plots was referenced to a permanent center hub, assigned a number and identified by species;

and the diameter and merchantable height were recorded. As the need arose, all physical and historical data (natural mortality, depletion by logging, changes in volume due to growth, etc.) were brought up to date by remeasuring the plots. Tenth-acre circular subplots were installed on the odd-numbered 1/5-acre plots to determine the volume, depletion, and growth of the cordwood portion of the stand (trees 4.6 to 9.5 inches diameter breast high) and the number and species of saplings ranging in size from 1.6 to 4.5 inches at d.b.h.

The 10-Year Cut (1947–1957)

The average gross sawtimber volume per acre in 1947, as estimated by sample plots, was 5,327 board feet.

During this 10-year cycle, 208 cords of fuelwood and 44,685 board feet, net log scale,[4] have been taken off the Forest (Table I).

TABLE I

Summary of Log and Cordwood Sales During the First 10-Year Cutting Cycle

Year	Logs—Net Volume by Species					Total Fuelwood, All Species
	Oak [1]	Maple [2]	Bass-wood	Other [3]	Total	
	Board Feet, Scribner					Cords
1947	1,290	5,835	135	950	8,210	20
1948	2,490	3,100	660	650	6,900	30
1949	7,450	670	3,460	70	11,650	20
1950	3,350	1,560	560	190	5,660	8.5
1954	610	3,810	230	920	5,570	19
1957	5,775	920	.....	.....	6,695	110.5
Total	20,965	15,895	5,045	2,780	44,685	208.0

[1] 96.4 percent northern red oak, 3.6 percent white oak.
[2] 97.6 percent sugar maple, 2.4 percent red maple.
[3] 34 percent aspen, 28 percent elm, 23 percent paper birch, 5 percent white and black ash, and 10 percent miscellaneous.

If it is assumed that this 10-year cut was spread uniformly over the entire timber harvest forest, it amounts to 687 board feet, net log scale, plus 3.2 cords of fuelwood per acre, or an average annual depletion rate per acre of about 69 board feet and 0.32 cord, respectively.

[4] The 100-percent cruise showed 6,110 board feet per acre. The difference of 783 (due to sampling error as well as to human error) is rather large, but does not invalidate conclusions based on periodic comparisons of sample plot data.

TABLE II

EFFECT OF LOGGING AND NATURAL MORTALITY ON STOCKING, BASAL AREA, AND AVERAGE DIAMETER DURING THE FIRST DECADE OF MANAGEMENT

SPECIES [1]	TOTAL TREES PER ACRE		TOTAL BASAL AREA PER ACRE [2]		AVERAGE D.B.H. [3]	
	1947	1957	1947	1957	1947	1957
	No.	No.	Sq. Ft.	Sq. Ft.	In.	In.
CORDWOOD TREES [4]						
Northern red oak	20.6	13.4	8.35	6.02	7.4	7.6
White oak	7.6	5.3				
Sugar maple	95.9	74.6	12.28	10.24	4.7	4.9
Red maple	5.9	4.7				
Ameriean basswood	7.1	4.1	5.20	4.87	5.3	5.7
Slippery elm	13.5	11.2				
White ash	12.3	11.2				
Paper bireh	1.2	1.2				
Shagbark hickory	24.1	16.4	4.83	3.89	6.1	6.7
Ironwood	81.8	56.9	5.52	4.67	3.5	3.9
Total or average	270.0	199.0	36.18	29.69	5.0	5.2
SAWTIMBER TREES [5]						
Northern red oak	35.9	35.3	39.66	43.67	13.3	14.1
White oak	5.0	4.7				
Sugar maple	12.1	12.8	12.71	12.31	13.5	13.1
Red maple	0.7	0.4				
Ameriean basswood	2.9	1.8	10.16	8.88	14.7	14.7
Slippery elm	2.6	2.8				
White ash	1.9	2.5				
Paper bireh	1.2	0.4				
Shagbark hiekory	0.7	1.3	0.42	0.76	10.5	10.4
Total or average	63.0	62.0	62.95	65.62	13.5	13.9
Grand total or average	333.0	261.0	99.13	95.31	7.4	8.2

[1]A few bur oak, green ash, blue beech, and Ameriean elm, together averaging 5.6 trees per acre, were also present.

[2]Total eross-seetion area in square feet of all tree stems on an aere, at a height of 4½ feet above the ground.

[3]Diameter at breast height (d.b.h.) as determined from total basal area divided by total trees.

[4]Those stems between 4.6 to 9.5 ineh̄es at d.b.h.

[5]Trees 9.6 inches or larger at d.b.h.

Changes in Stocking, Basal Area, and Average Diameter as a Result of Logging

The sample plot records show the cumulative effect of the six individual harvests on the structure of the stand. After 10 years the total number of trees per acre had been reduced 22 percent and the basal area 3.82 square feet (Table II). Growing stock of cordwood size was affected more, proportionately, by logging than were the trees of sawtimber size.

TABLE III

Relationship Between the Average Diameter of Hardwoods in 1947 and Their Corresponding Diameter in 1957

D.b.h. in 1947	Average d.b.h. in 1957 by Species Groups[1]		
	Group I	Group II	Group III
(in.)	(in.)	(in.)	(in.)
2.0	2.3	.....	2.3
3.0	3.4	.....	3.3
4.0	4.5	.....	4.3
5.0	5.6	.....	5.3
6.0	6.7	.....	6.4
7.0	7.8	.....	7.4
8.0	8.9	.....	8.5
9.0	9.9	.....	9.5
10.0	11.0	.....	10.6
11.0	12.1	.....	.....
12.0	13.1	.....	.....
13.0	14.2	.....	.....
14.0	15.2	.....	.....
15.0	16.3	.....	.....
16.0	17.3	17.2	.....
17.0	18.4	18.2	.....
18.0	19.4	19.2	.....
19.0	20.5	20.2	.....
20.0	21.6	21.3	.....
21.0	22.6	22.3	.....
22.0	23.7	24.3	.....
23.0	24.7	24.3	.....
24.0	25.8	25.3	.....

[1]*Basis for averages:* Group I, 604 trees; Group II, 210 trees; and Group III, 97 trees. *Applicability of Table Values:* Group I—to all hardwoods except as noted in Groups II and III; Group II—to sugar and red maple in the 16- to 24-inch d.b.h. range; and Group III—to ironwood and blue beech.

This decrease in stocking was accompanied by an increase in the average diameter, breast high (d.b.h.), of the residual stand. The actual changes in diameter varied with the size of the trees in 1947 and by species groups (Table III). Small items, which usually were in the suppressed and intermediate crown classes, naturally grew more slowly than large ones, and ironwood, blue beech, and those

maples exceeding 15 inches d.b.h. showed less change than northern red oak, elm, basswood, and white ash.

The cutting budget for the Dundee Timber Harvest Forest has been very conservative. During the first 10-year management period, 1,045 board feet of the initial (1947) gross sawtimber volume of 5,327 board feet per acre were cut or succumbed to natural mortality (table 4). The residual stand of 4,282 board feet per acre added 1,836 board feet of growth in a decade, and 333 board feet accrued from pole-sized trees which attained sawtimber status since the plots were established in 1947. Thus the total gross sawtimber volume in 1957 amounted to 6,451 board feet per acre or 21 percent more than the initial volume at the start of the cutting cycle.

TABLE IV

TEN-YEAR CHANGES IN THE GROSS SAWTIMBER VOLUME PER ACRE

(In board feet, Scribner Log Rule)

SPECIES	STAND VOLUME IN 1947	10-YEAR MORTALITY [1]	10-YEAR CUT [2]	STAND VOLUME IN 1957
Northern red oak	3,252	41	438	4,183
Sugar maple	922	20	271	988
Slippery elm	328	28	14	453
American basswood	417	0	205	269
White ash	121	0	10	192
White oak	168	0	12	257
Red maple	38	0	20	27
Shagbark hickory	20	0	8	47
Paper birch	51	0	49	19
Bur oak	2	0	2	4
Aspen	8	0	10	0
American elm	0	0	0	2
Black cherry	0	0	0	10
Total	5,327	89	1,039	6,451

[1]Includes 2 board feet of growth between 1947 and time of death.
[2]Includes 81 board feet of growth between 1947 and time of cut.

Corresponding net sawtimber volumes per acre were 4,763 and 5,890 board feet in 1947 and 1957, respectively (fig. 2). Harvests removed 741 board feet (734 board feet of the original stand plus 7 board feet of growth which these trees added prior to being cut). The net mortality was 5 board feet. Of the 1,933 net board feet of growth which accrued during the past 10 years, 1,625 board feet or 84 percent was added to trees which were in the 1947 sawtimber stand, and 308 board feet or 16 percent came from pole-sized stems.

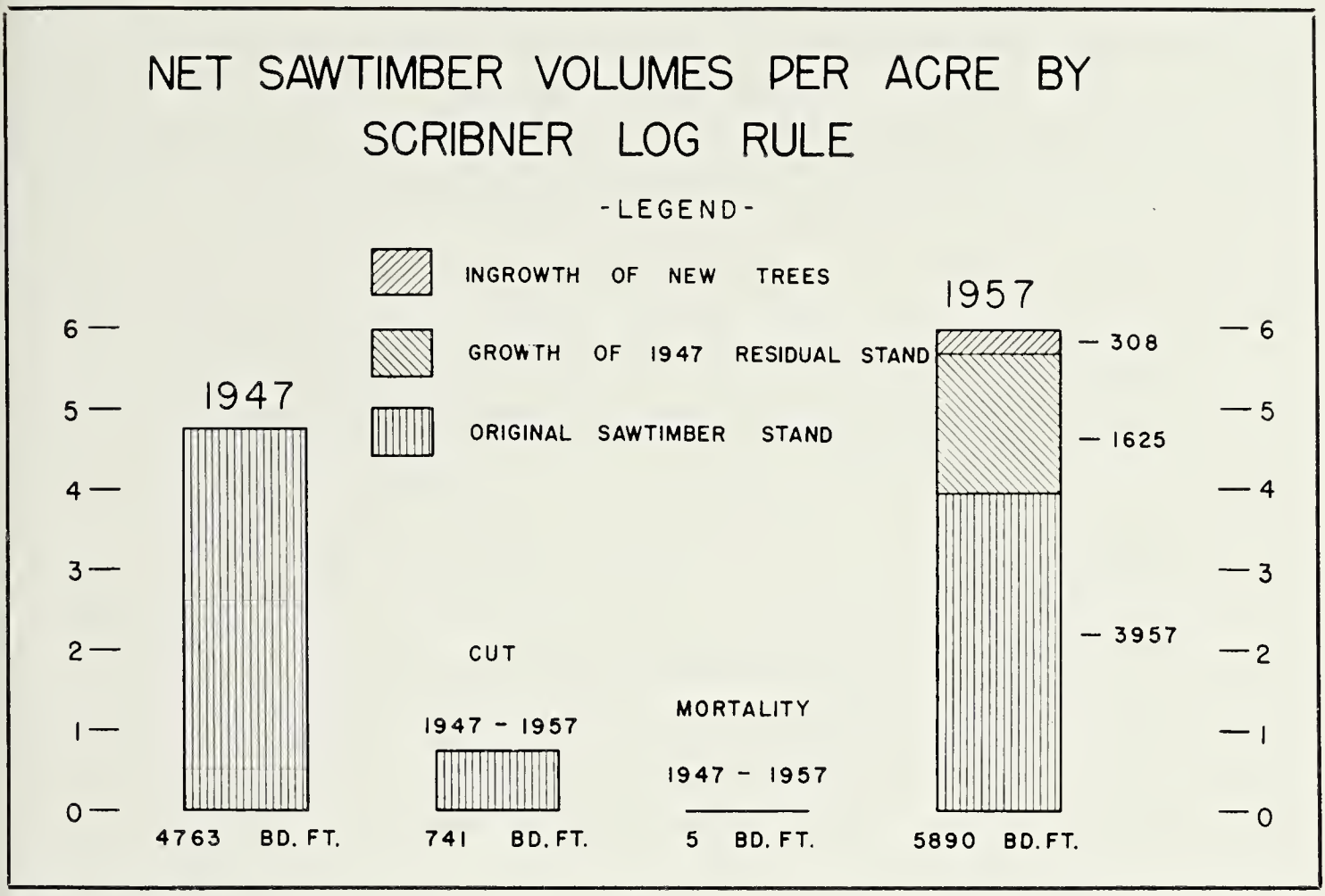

FIGURE 2. There was a net volume increase of 1,127 board feet per acre during the first decade of controlled cutting on the Timber Harvest Forest. This objective was accomplished by keeping depletion (cut and mortality) at approximately 40 percent of the total volume added by growth.

TABLE V

TEN-YEAR CHANGES IN THE VOLUME OF THE CORDWOOD STAND
(In cords per acre)

SPECIES	1947 VOLUME	MORTALITY [1]	CUT [1]	TOTAL GROWTH	1957 VOLUME IN TREES OF CORDWOOD SIZE	1957 VOLUME IN TREES BECOMING SAWTIMBER SIZE
Sugar maple	1.465	0.016	0.331	0.751	1.336	0.533
Northern red oak	1.232	.017	.052	.723	1.105	.781
Shagbark hickory	.647	.071	.101	.241	.716	.....
Slippery elm	.412	.055	.022	.295	.370	.260
White oak	.277	.017	.079	.073	.254	.....
White ash	.265	.052	.....	.202	.415	.....
Ironwood	.247	.040	.024	.138	.321	.....
Red maple	.076	.....	.031	.029	.074	.....
American basswood	.075	.030	.....	.078	.123	.....
Other hardwoods [2]	.030	.....	.....	.026	.056	.....
Total	4.726	0.298	0.640	2.556	4.770	1.574

[1]Including growth which accrued on these trees prior to their death or removal from the stand by logging.

[2]Paper birch and bur oak.

This transition from nonsawtimber to sawtimber status amounted to 1.57 cords per acre in 1957, and depletion (trees that were cut or died) accounted for another 0.94 cord. In spite of this loss of 2.51 cords, there was slightly more cordwood per acre in 1957 than in 1947—4.77 cords versus 4.73 cords (Table V; fig. 3).

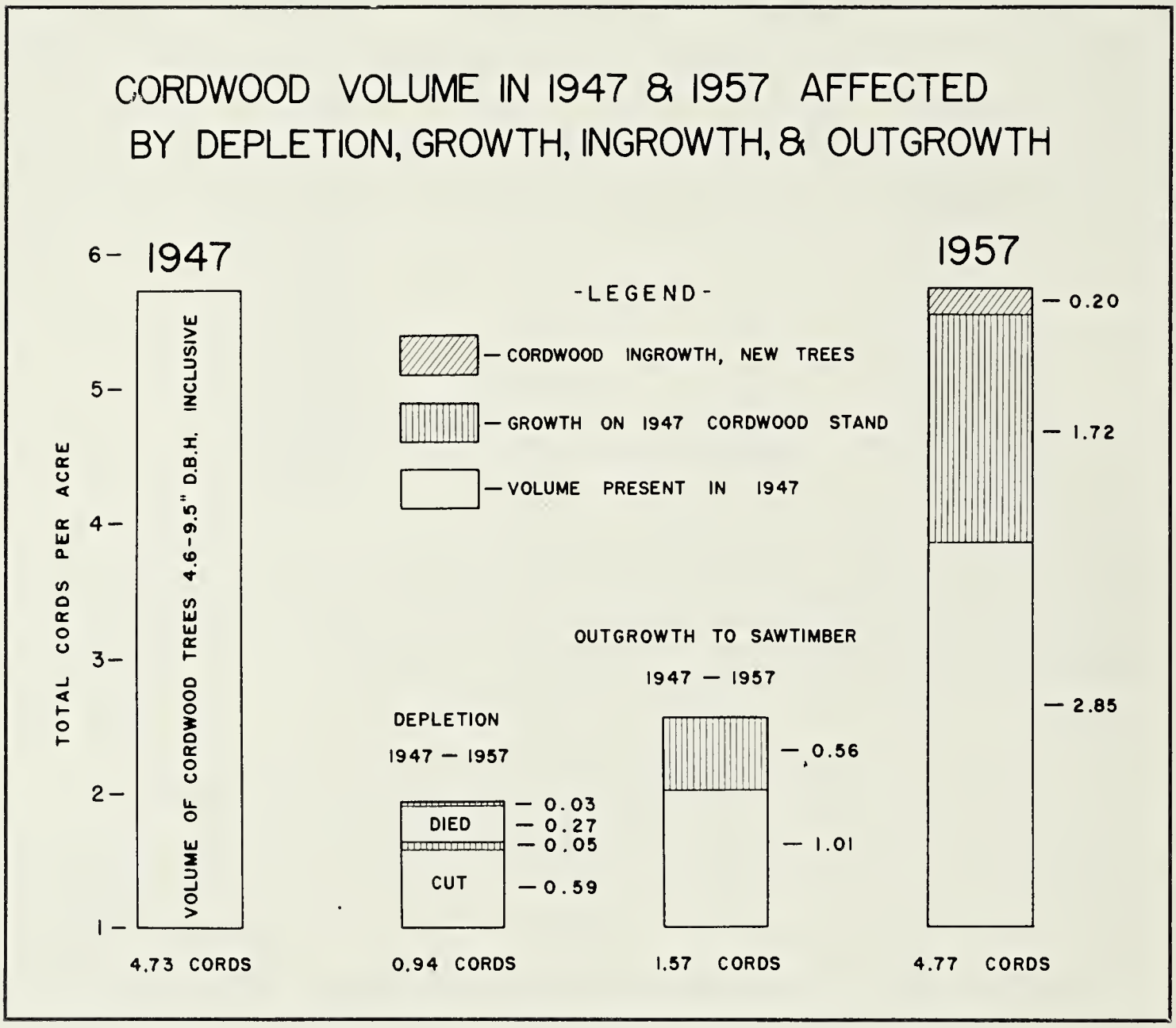

FIGURE 3. The total volume of cordwood changed only fractionally between 1947 and 1957 in the Dundee Woods. During this period, the original understory was reduced 1.9 cords per acre by logging, mortality, and sawtimber outgrowth as compared to new-tree additions of 0.2 cord per acre. If this unfavorable ratio between depletion and replacement persists there will be a progressive and accelerated loss of volume in the cordwood understory.

The less desirable species (ironwood, red maple, and shagbark hickory) accounted for 48 percent—67.6 out of 140.0 trees per acre—of all the small saplings present in the stand in 1947 (Table VI). Ironwood and sugar maple together comprised about 83 percent of this advance regeneration, whereas northern red oak, which accounted for about 8 percent of the cordwood-sized stems (4.6 to 9.5 inches at d.b.h.) and 57 percent of the sawtimber stand, was represented by less than 1 percent of the saplings in the understory.

Natural mortality and losses due to logging reduced the 1947 stocking of these 1.6- to 4.5-inch trees of all species by 23 percent. The high degree of suppression which they suffer is indicated by the fact that only 11 percent of them had attained a minimum cordwood size (4.6 inches d.b.h. with at least one 8-foot stick to a 4-inch top) by 1957.

TABLE VI

REDUCTION IN THE NUMBER OF SMALL[1] SAPLINGS PER ACRE BY VARIOUS FACTORS DURING THE PERIOD OF 1947 TO 1957, INCLUSIVE

Species	Total Trees in 1947	Status of These Same Saplings in 1957			
		Trees are Dead or Missing	Trees were Cut [2]	Trees are still alive but have:	
				Attained Cordwood Size	No Cordwood Volume
	Number	Percent	Percent	Percent	Percent
Sugar maple	56.5	13	2	11	74
Northern red oak	1.2	50	.....	50	.....
Shagbark hickory	1.8	33	.....	34	33
Slippery elm	4.1	15	.....	44	41
White oak	1.2	.....	.....	.....	100
White ash [3]	5.3	11	.....	11	78
Ironwood	59.3	28	5	6	61
Red maple [4]	6.5	.....	9	9	82
American basswood	3.5	49	.....	17	34
Other hardwoods	.6	.....	.....	100	.....
Total	140.0	20	3	11	66

[1]These trees ranged from 1.6 to 4.5 inches d.b.h. in 1947.
[2]These stems were cut to expedite the felling of larger trees.
[3]Includes 0.6 green ash per acre.
[4]Includes 2.6 blue beech per acre.

EXPERIMENTAL STUDIES IN OAK MANAGEMENT

Northern red oak appears to be ideally adapted to the site conditions found on the Dundee Timber Harvest Forest. It also ranks as one of the high-value species in the farm woodlands of Wisconsin. For these two reasons alone, it is of paramount importance to retain this tree as the main component of the stand. As just shown above, the prospects for doing this are almost nil from the standpoint of any restocking which may be expected from the present sapling understory.

The key to the future situation seems to depend, then, upon: (1) how much of the seedling reproduction currently occupying the area is northern red oak, and (2) the degree of success with which

FIGURE 4. Systematic counts were made of the tree seedlings in the south unit of the Forest in the winter of 1956–1957. The information obtained indicated that the time was ripe to start thinning the overstory of mature oak.

these small trees can overcome the competition from herbaceous vegetation and woody shrubs after the merchantable overstory is opened up or removed.

Reproduction tallies made in 1947 and again in 1956–1957 (fig. 4) provide a partial answer to the first question: It does not appear likely that northern red oak can be maintained as a dominant species in the 17-acre pole-sized stand comprising the north unit of the forest. In that part of the woods, seedlings of this species account for only 3 percent of the total regeneration (Table VII), and they are competitively at a disadvantage with the more tolerant species such as sugar maple, red maple, American basswood, slippery elm, and ironwood.

TABLE VII

Periodic Checks of Natural Regeneration

Species	Number of Seedlings per Acre by Height Classes					
	North Unit [1]			South Unit [2]		
	Less than 1 Foot	1 to 15 Feet	Total	Less than 1 Foot	1 to 15 Feet	Total
Northern red oak....	440	20	460	1,852	160	2,012
Sugar maple.....	4,040	1,800	5,840	222	62	284
Ironwood.....	5,560	460	6,020	247	667	914
White ash.....	540	560	1,100	259	457	716
Elm (mostly slippery)	460	20	480	99	284	383
Black cherry.....	300	20	320	124	222	346
Red maple.....	240	0	240	333	62	395
Bur oak.....	160	0	160	0	12	12
American basswood..	120	20	140	12	87	99
Shagbark hickory....	80	0	80	99	0	99
Bigtooth aspen.....	20	20	40	0	0	0
Total.....	11,960	2,920	14,880	3,247	2,013	5,260

[1]Based on a total sample of 50 milacres taken on 5 permanent 1/5-acre plots in September 1947.

[2]Based on 81 milacre plots taken at random in the north half of the south unit in 1956–1957.

Any attempt to eliminate such shade-enduring trees in order to encourage the northern red oak seedlings would be expensive, time-consuming, and almost certainly doomed to failure. Therefore, the obvious course of action for this part of the woods is to make the best use possible of the present mixture—and forget the oak.

The situation in the 48-acre south unit is much different. There, northern red oak totals 38 percent (2,012 trees per acre) of the seedling regeneration (Table 7). The requisites for successfully establishing sapling stands of this species are: (1) adequate light

and (2) expeditious weeding to reduce competition from woody shrubs and undesirable trees. The beneficial effects of this type of silvical treatment already have been demonstrated on the Dundee Forest area by a small clear-cutting study (*5*).

The favorable results obtained from the clear-cutting experiment, plus the fact that northern red oak reproduction averages about

FIGURE 5.—In November 1957, a 5.12-acre block of oak timber in the south unit of the Forest was thinned from below by a shelterwood preparatory cutting. This picture shows the residual stand after logging was completed.

2,000 trees per acre in the south unit, provided the technical background for a shelterwood cutting in this part of the woods late in 1957. Approximately 24 square feet of basal area per acre were removed by the initial (preparatory) phase of this silvicultural operation; about 12 square feet were in red oak, 5 in sugar maple, with the remaining area included in 8 other species.

A summary of data from 5 permanent 1/5-acre sample plots in or adjacent to the 5.12-acre shelterwood unit shows that the 1957 pre-logging stocking and basal area of trees 4.6 inches d.b.h. and larger were 108 stems and 118.0 square feet per acre respectively.

The preparatory cut took out 29 cordwood-size and 19 sawtimber trees per acre. In removing these 48 stems, the density of the stand

FIGURE 6. More than 100 farmers, interested laymen, and technicians attended the last field-day program which was held in the south unit of the Forest in November 1957. Most of these visitors came for the expressed purpose of obtaining information which they could use in managing their own woodlands.

was reduced by 44 percent and its basal area by 20 percent. Northern red oak accounted for 74 percent of the trees cordwood-size or larger on the area prior to treatment as compared to 36 percent of the trees which were felled.

The general objective of the first cut was to provide more crown and bole space for the dominant and codominant northern red oak

seed trees by eliminating the understory (Fig. 5). Timing and severity of the second and final harvests will depend upon the success of establishing natural regeneration and upon its rate of development. In specific instances this process of restocking can be hastened by scarifying the soil (*4*).

Field-Day Programs

Five scheduled, and one unscheduled,[5] harvests were made on the Dundee tract during the past 10 years. Field days were held on four of these occasions for the benefit of the general public, and some 775 people (farmers, other owners of small acreages of woodland, and technicians) received instructions on how to manage their farmwoods to the best advantage (Fig. 6).

Programs are planned to provide elementary instructions in cruising and scaling; demonstrations of up-to-date felling, skidding, and loading equipment; and on-the-ground discussions of why certain trees are cut and others left. An additional objective is to show visitors exactly what an annual or periodic cut means in terms of forest products—veneer and sawlogs, box bolts, and fuelwood—which are decked and held at strategic points for this specific purpose.

It is believed that most of the people who own small acreages of timber in rural sections of the state are neither disinterested in, nor hostile toward the practice of forestry. They simply do not understand it.

When farmers and other interested landowners visit this woods, they have an opportunity to see at firsthand how timber is cruised, marked for cutting, felled, bucked into logs, etc. In a short afternoon, much of the "mystery" surrounding forestry has been stripped away. Invariably, some of these visitors solicit technical assistance for managing their own woodlands before they leave these field meetings.

The Dundee tract is one of nine publicly-owned Timber Harvest Forests which have been established in Wisconsin to encourage forestry practices in farm-owned timberlands (*7*).

Economic Returns

Much has been said and written about the "economics" of farm forestry, and favorable monetary returns for specific ownerships have been reported from various parts of the country (*1*), (*2*), (*8*), and (*9*).

An analysis of the publications pertaining to these woodlands shows that almost invariably they: (1) are moderately to well-

[5] A salvage operation was necessary in 1950 because two severe windstorms blew down about 6,000 board feet of sawtimber in the north unit of the forest.

stocked, (2) yield salable products, and (3) are located in areas having well-established, competitive markets. Profits are also influenced by the method and efficiency of logging, timber quality, tree species, and site conditions (as reflected by annual or periodic growth rates).

The Dundee Timber Harvest Forest is an excellent example of the kind of woods that will assure a continuous income under proper management. The total gross receipts for logs and bolts during the first 10 years was approximately $1,860 (Table VIII).

TABLE VIII

Gross Receipts From the Dundee Timber Harvest Forest

Year	Net Scale of Logs Cut	Actual Returns for Logs and Bolts		Estimated Value of Same Products as Stumpage	
		Total	Per M Bd. Ft.	Total	Per M Bd. Ft.
	(M Bd. Ft. Scribner)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
1947	8.21	345.17	42.04	123.15	15.00
1948	6.90	363.36	52.66	103.50	15.00
1949	11.65	486.34	41.75	174.75	15.00
1950	5.66	258.67	45.70	84.90	15.00
1954	5.57	209.60	37.63	83.55	15.00
1957	6.70	196.40	29.31	100.50	15.00
Total or average	44.69	1,859.54	41.61	670.35	15.00

If stumpage, rather than cut products, had been sold, it would have provided a minimum gross income of about $670. The difference ($1,190 or $26.61 per M bd. ft.) between these two totals is the amount the State of Wisconsin "collected" by doing its own logging.

A private landowner has this same option; i.e., he can sell either stumpage or cut products. However, in the latter instance, he assumes the usual entrepreneur's risk, and the amount of profit he makes, or loss that he sustains, depends entirly upon his efficiency and experience, how well he is equipped to do the job, his ability to sell his products at top market prices, etc. Since no two farmwoods-management situations will be identical in all particulars, it is almost meaningless to use a cost-return analysis for one property as a basis of what may be expected from another. The farmer who grows and harvests his own timber will be affected, just as commercial operators are, by the year-to-year changes in market prices—which, in turn, determine what can be paid for stumpage, labor, truck and equipment rentals, and all similar expenses.

In general terms, the success of any farm forestry program will depend upon the following factors: (1) the composition of the stand—some tree species always are worth more than others; (2) timber quality—clear wood is more valuable than material that is full of knots, rot, and other defects; (3) the volume of the annual or periodic allowable cut; (4) timing of harvests to take advantage of peak market prices; and (5) logging efficiency—including the use of up-to-date equipment.

Anything a woodland owner can do to improve the status of any or all of these factors will mean more dollars in his pocket. Conversely, a culled-over farmwoods of scattered, low-value trees always serves to emphasize the truthfulness of the old adage that "nothing begets nothing."

Summary

1. From an initial inventory of 5,327 board feet of standing timber per acre, a succession of six harvest cuts removed 44,685 board feet of sawlogs and 208 cords of fuelwood over a 10-year period.

2. Gross additions of new wood amounted to 2,169 board feet per acre during the first decade of management. Of this total, 1,836 board feet accrued on a 4,282 board-foot, uncut "base" left from the 1947 sawtimber stand. The balance of 333 board feet represents ingrowth from pole-sized stems to sawtimber status *after* the plots were established. Thus, the total gross volume of the stand in 1957 was 6,451 board feet per acre or 21 percent greater than it was just prior to the first scheduled harvests in the fall of 1947.

3. It appears unlikely that northern red oak can be maintained indefinitely in stands where seedlings of this species comprise only a small percentage of the total regeneration (about 3 percent in the north unit). The presence of sugar maple, ironwood, and other shade-tolerant trees increases competition and worsens the plight of the oak.

4. On the other hand, where northern red oak accounts for as much as 38 percent of the current seedling reproduction, as it does in the south part of the forest, the shelterwood system of cutting offers reasonable assurance of continued dominance by this species.

5. Ten years of forest management have improved the Dundee Forest in terms of volume and timber quality. This has been accomplished by removing as many poor trees as possible during each of the six harvests and by cutting less wood than was added by growth.

6. It is estimated that the merchantable mixed-oak stands which characterize the woodlands of eastern Wisconsin will attain physical maturity at an age of 150–160 years. Applied to the Dundee tract, this provides a grace period of three to four 10-year cutting cycles to establish natural regeneration.

7. Public field-day programs were held immediately following four of the six cutting operations, with a combined attendance of about 775 farmers, agricultural students, and land-use specialists (foresters, agricultural planners, etc.). These activities provided technical stimulus and guidance for eastern Wisconsin farmers interested in improving their woodlands.

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A PHYTOSOCIOLOGICAL STUDY OF THE UPLAND FOREST COMMUNITIES IN THE CENTRAL WISCONSIN SAND PLAIN AREA[1]

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The forest communities in the central Wisconsin sand plain area comprise a mosaic of vegetational elements from both southern and northern Wisconsin. This region can essentially be considered a transitional or ecotonal zone between the southern and northern forest communities. The southern Wisconsin component of this ecotone zone is prairie-hardwood (Curtis and McIntosh, 1951), and the northern component is conifer-hardwood (Brown and Curtis, 1952).

The central Wisconsin ecotone is considered synonymous with what is known as a tension zone (Curtis and McIntosh, 1951). It is possible to plot this tension zone in Wisconsin by noting the range limits of plant species which are common to and characteristic of the two contiguous floristic provinces. The delineation of the Wisconsin tension zone, using species' range limits, is fully discussed by Curtis and McIntosh (1951). The tension zone lies generally in a northwest–southeast direction, and is closely related to the positions of many climatic isolines, such as summer temperature and snow depth. Here the isolines are bunched, and a steep gradient exists from south to north across the tension zone.

A phytosociological study of the upland forest communities in the central Wisconsin sand plain area was initiated primarily to aid in an accurate description of the winter range of the white-tailed deer (*Odocileus virginianus*) in this region (Habeck, 1959). The phytosociological behavior of the important winter browse species in the upland forest communities was the specific objective of this study. In order to make a meaningful study of the browse species, however, a detailed investigation of the forest communities in their entirety was necessary. This paper is devoted primarily to a description and discussion of the phytosociological methods used in the ordination of the upland sand plain forest communities and a presentation of the results of this ordination. The field work was done during the summer of 1958. Nomenclature used in this report follows that of Gleason (1952). The writer wishes to extend his appre-

[1] This study was conducted in cooperation with the Wisconsin Conservation Department and was financed with Federal Aid to Wildlife Restoration funds under Pittman-Robertson Project W–79–R.

ciation to Dr. J. T. Curtis, Botany Department, University of Wisconsin, for his aid in this study.

Physiography of the Study Area. Two principal regions in the central Wisconsin sand plain area were included in this study; the Central Wisconsin Conservation Area (C.W.C.A.) located in the northwestern portion of Juneau county and parts of Monroe county, and the Black River State Forest situated in central Jackson county (Figure 1). These two state-owned tracts comprise approximately 116,000 acres. Several localities adjacent to these two main areas were also studied; Castle Mound Roadside Park was one of these areas.

Both of the main study areas are located within the Wisconsin Driftless Area, and the C.W.C.A. lies entirely within the bed of Glacial Lake Wisconsin (Martin, 1932). Whitson, *et al.* (1914, 1923) describe this portion of central Wisconsin as a generally level sand plain with occasional sandstone and quartzite hills projecting 20 to 200 feet above this plain. Marshes are also very prevalent throughout the sand plain area.

Northern Juneau county is drained primarily by the Wisconsin River, with the Yellow River and Little Yellow River as principal tributaries. Central and eastern Jackson county is drained by the Black River, with Morrison Creek, Lewis Creek and East Fork Black River serving as the main tributaries.

Vegetation History. Roth (1898) provided a general picture of the vegetation in Juneau and Jackson counties prior to the turn of the 19th century. Roth stated that much of the central Wisconsin sand plains was covered with scrub oak (*Quercus ellipsoidalis*) and jack pine (*Pinus banksiana*) openings, with some portions covered with dense groves of jack pine and a few islands of mature red pine (*Pinus resinosa*) and white pine (*Pinus strobus*). Mesic upland hardwood forests were apparently not present or not common enough to draw Roth's attention. Roth further stated that there were "extensive bare wastes" which he believed were the result of logging and burning.

Bordner, *et al.* (1934) presented a rather detailed account of the prairies and openings existing in northern Juneau county during the early 1930's, before intensive fire control. Big blue stem (*Andropogon Gerardi*) and little blue stem (*A. scoparius*) were very common along with other typical prairie plants such as Indian grass (*Sorghastrum nutans*), tickseed (*Coreopsis palmata*), blazing star (*Liatris pycnostachya*), lead plant (*Amorpha canaescens*) and false indigo (*Baptisia bracteata*). These writers reported that fire and drainage were both conducive to the establishment and maintenance of prairie conditions in this central Wisconsin region and they believed that the cessation of fires and the elimination of marsh drain-

age would cause a forest flora to assert itself. Today, twenty-five years later, it is apparent in the central Wisconsin sand plain area that the forest flora is replacing the prairies and openings as a result of fire control alone.

Agricultural activity in the central Wisconsin sand plain area was well underway by the 1850's. Much of the native vegetation was disturbed and many of the marshes were drained for cropland. The period of most active marsh drainage occurred between 1880 and 1920 (Catenhusen, 1950). Primarily as a result of low soil fertility nearly all agricultural activity was abandoned by the late 1930's. The Resettlement Administration aided many settlers to move to other parts of the state.

Because of the ecotonal nature of this region, it is very difficult at the present time to reconstruct a completely accurate vegetational picture of the past forests and prairies in the central Wisconsin sand plain area. This is particularly true in regard to the areal distribution of the prairies, openings and forests. A complete understanding of the past history of the vegetation is further complicated by the fact that fire was as much a factor in the vegetational history in central Wisconsin as it was in southern Wisconsin.

Methods

Data for this study were collected from forty forest communities in the areas described earlier. The field methods which were to be used in this study needed to be rather rapid and accurate as well as usable by a single operator. In sampling the tree vegetation, the Quarter method, as described by Cottam and Curtis (1956), was employed.

In using the Quarter method, a starting point was chosen at random and a second point, 30 paces (about 45 yards) along a predetermined compass direction, was established. Using the compass line as a base line, the area around the point was divided into four imaginary quarters. In each of the four quarters, the species and size of each tree nearest the point was determined as well as the distance of each tree to the point. The basal area of the trees was measured as an index of their size and this measurement was taken at 4.5 feet above the ground. In this study a tree was defined as any individual four inches or more in diameter at breast height. A total of twenty sampling points was studied in each stand so that a total of eighty trees was recorded in each stand.

In addition to the collection of the tree data at each sampling point, the distance from the point to the edge of the nearest shrub was measured in each of the four quarters. These shrub data were collected to determine if shrub cover exerted an influence on the ground-layer browse species. An efficient method of measuring abso-

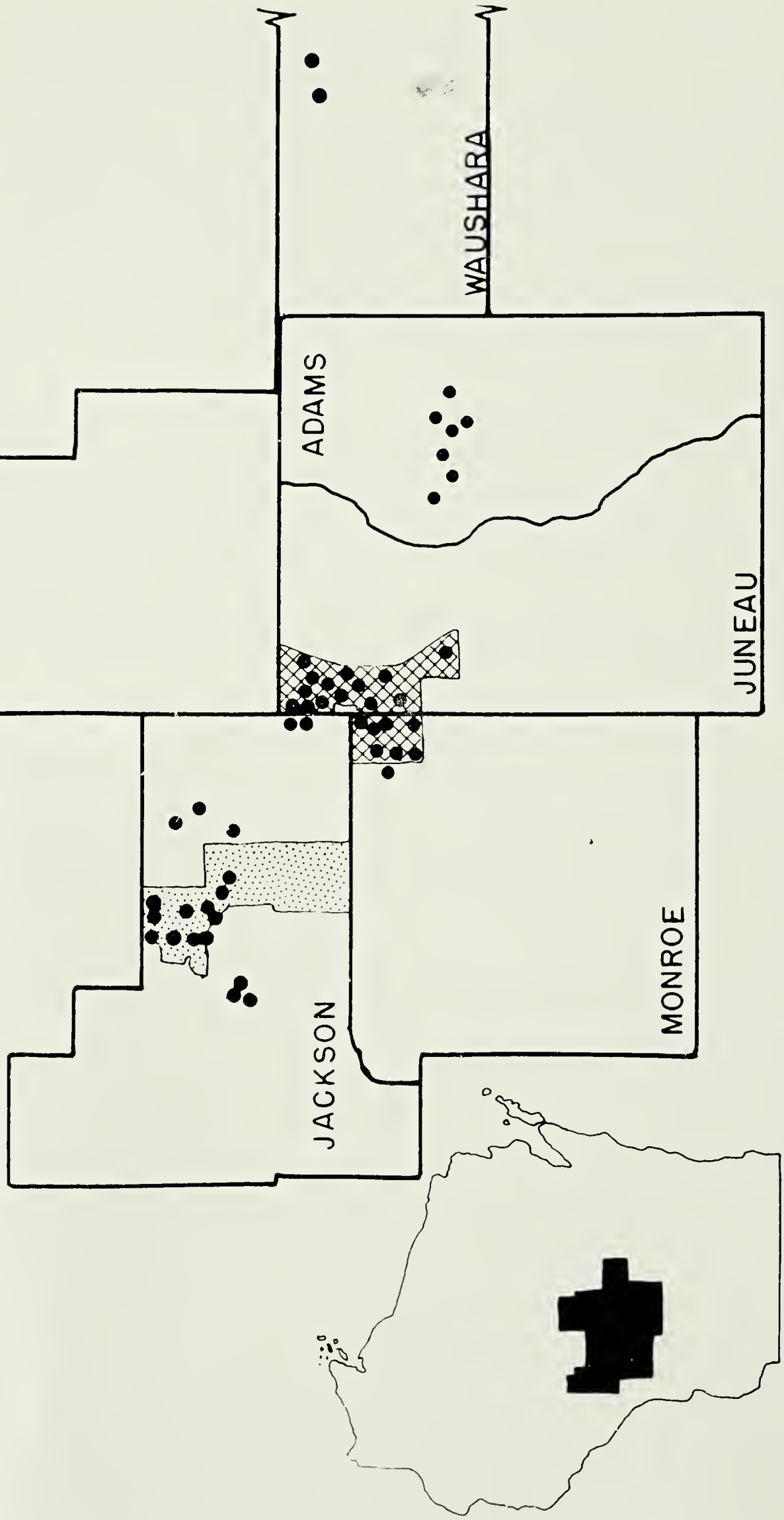


FIGURE 1. Location of study areas in the central Wisconsin sand plain. The Black River State Forest is located in Jackson county and the Central Wisconsin Conservation Area is located in Juneau and Monroe counties. Scale: one inch equals sixteen miles.

lute shrub cover has not as yet been devised, but the average of eighty shrub distances for any given stand does serve as a satisfactory indication of the absolute shrub cover.

Estimates of the tree canopy cover were also made in each of the four quarters at each of the twenty sampling points. During the time in which the stand was sampled, a running compilation of the total flora was made, resulting in a total presence list of all the species found in the stand.

As it was desirable to collect data from a wide range of forest community types in order to interpret the phytosociological behavior of the browse species, the stands were selected subjectively. None of the stands studied had been recently disturbed by fire or cutting, and all were larger than twenty-five acres in size. The majority of the forest area in the sand plain area is covered with pure stands or mixtures of jack pine and scrub oak, and it was difficult to locate sufficient numbers of the more mesic community types such as red pine-white communities and red oak-red maple (*Quercus rubra-Acer rubrum*) communities. In order to gain a more meaningful picture of the phytosociological behavior of both the tree and ground-layer species, the data from seven stands studied in nearby Adams county and two stands from Waushara county (Brown, 1950) were incorporated with the data collected by the writer (Figure 1).

Laboratory Methods. In the Plant Ecology Laboratory at the University of Wisconsin, the field data were tabulated on summation sheets. For each stand the relative density, relative dominance and relative frequency were calculated for each tree species (Cottam and Curtis, 1956). These three values were summed, resulting in a single index or importance value for each tree species in each stand. As these values are calculated as percentages, the over-all total of importance values for one stand is 300. According to Curtis and McIntosh (1951), the importance values permit a better comparison of any species in different stands than any one of the components making up the importance values. In addition to these calculations, the number of trees per acre, the average tree canopy cover and the average shrub distance were determined for each stand. The nine stands incorporated from Adams and Waushara counties did not have tree canopy or shrub distance data.

Phytosociological Ordination of the Stands. The arrangement of the central Wisconsin sand plain forest communities into a compositional order, as has been done for other plant communities in Wisconsin (Curtis and McIntosh, 1951; Brown and Curtis, 1952; Curtis, 1955), was thought to be the best means of describing the phytosociological behavior of the vegetation.

A phytosociological ordering of the stands is possible by using as a basis either the tree species or the ground-layer species. There are several reasons which make inadvisable the exclusive use of the tree species for ordering all forty-nine of these stands. One reason is the intermixing of the northern and southern Wisconsin communities in this ecotone region. Of the forty-nine stands, sixteen possess understories which are typically prairie-like and the remaining thirty-three stands possess understories which are typical of boreal or northern pine-hardwood forests. It is common to find forest communities, particularly those dominated by jack pine and/or scrub oak, which are very similar in tree composition, but which possess markedly different understories. In regard to jack pine stands, there is a tendency for the stands with a prairie flora to be less dense, either being openings or having recently developed from openings, whereas jack pine stands with boreal understories appear to be considerably more dense. Under these circumstances an ordination of all forty-nine stands on the basis of their tree composition could not possibly result in a meaningful arrangement.

A second drawback to using trees exclusively as a basis for ordering all of the sand plain communities is the fact that there is a relatively low number of different kinds of tree species occurring on the uplands in this region. A total of fifteen different tree species was recorded in this study, as compared with a total of thirty-one in the northern Wisconsin upland communities (Brown and Curtis, 1952) and twenty-two species in the southern Wisconsin upland communities (Curtis and McIntosh, 1951). Of these fifteen tree species, only eight can be considered common; the remaining were recorded infrequently. The data provided by eight tree species are not sufficient to result in an adequate community ordination.

For the purpose of making as complete and accurate presentation of the data collected in this study as possible, the data were treated in two different ways. First of all it was thought justifiable to separate the stands with a predominantly prairie understory from those possessing a boreal understory. This separation was done on the basis of the presence or absence of certain characteristic prairie plants such as *Andropogon Gerardi, A. scoparius, Coreopsis palmata, Helianthus occidentalis, Lithospermum canescens* and *Comandra richardsiana.* The twenty-five stands with boreal understories were combined with eight of the nine stands from Adams and Waushara counties which also possessed boreal understories. These thirty-three stands were arranged, by means of their trees, along a northern upland compositional gradient (Tree Composition gradient) using the tree adaptation numbers given by Brown and Curtis (1952). Thus, these particular communities were ordered on the basis of their tree composition alone.

The second method of community ordination employed in this study is a method developed by Curtis (1955) as a means of describing the prairie communities in Wisconsin. This method, called the Presence Index, permits the ordination of all forty-nine sand plain communities; the ground-layer species are used here as a basis for community ordination. In its adaptation to the forest communities in the sand plain area, three groups of ten understory indicator species were selected (Table I). These three groups of indicator species are known to be both very common and characteristic in three plant community types which may be described as prairie, dry boreal and mesic boreal. The prairie type is characteristic of southern Wisconsin. The dry boreal community type refers to the northern red pine-white pine communities, and the mesic boreal type refers to the northern Wisconsin upland hardwood communities.

TABLE I

PRESENCE INDEX INDICATOR SPECIES

Group I—Prairie Indicator Species

Andropogon Gerardi
Andropogon scoparius
Antennaria sp.
Coreopsis palmata
Comandra Richardsiana
Helianthemum canadense
Helianthus occidentalis
Krigia biflora
Lupinus perennis
Lithospermum canescens

Group II—Dry Boreal Indicator Species

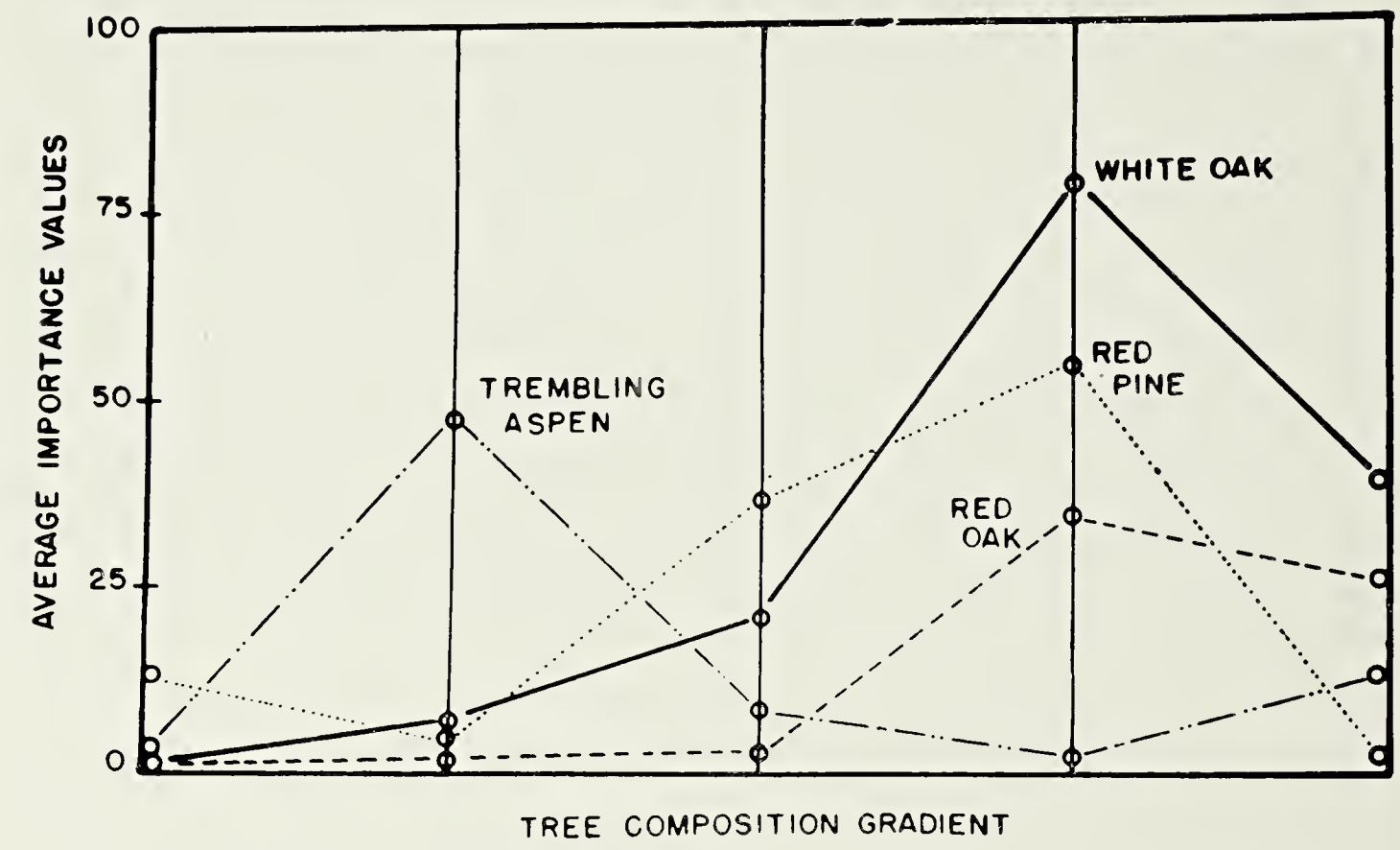
Anemone quinquefolia
Aralia nudicaulis
Arctostaphylos uva-ursi
Betula papyrifera seedling
Chimaphila umbellata
Cypripedium acaule
Diervilla lonicera
Epigaea repens
Melampyrum lineare
Myrica asplenifolia

Group III—Mesic Boreal Indicator Species

Brachyelytrum erectum
Clintonia borealis
Goodyera pubescens
Hepatica americana
Osmunda Claytoniana
Pyrola elliptica
Smilax herbacea
Smilacina racemosa
Trientalis borealis
Viburnum acerifolium

In calculating the Presence Index for any given stand, the number of these indicator species which are present in the stand is determined, and then the index number is arrived at by making a weighted average of the group values. The number of the prairie indicators is weighted by 1, the number of dry boreal indicators by 2, and the number of mesic boreal by 3. The resulting Presence Index has a theoretical range of 100 to 300. Below is given an example: a stand has 7 prairie indicators, 4 dry boreal and 1 mesic boreal,

$$\frac{(7 \times 1) + (4 \times 2) + (1 \times 3)}{(7 + 4 + 1)} = \frac{18}{12} = 1.500 \times 100 = 150.0$$



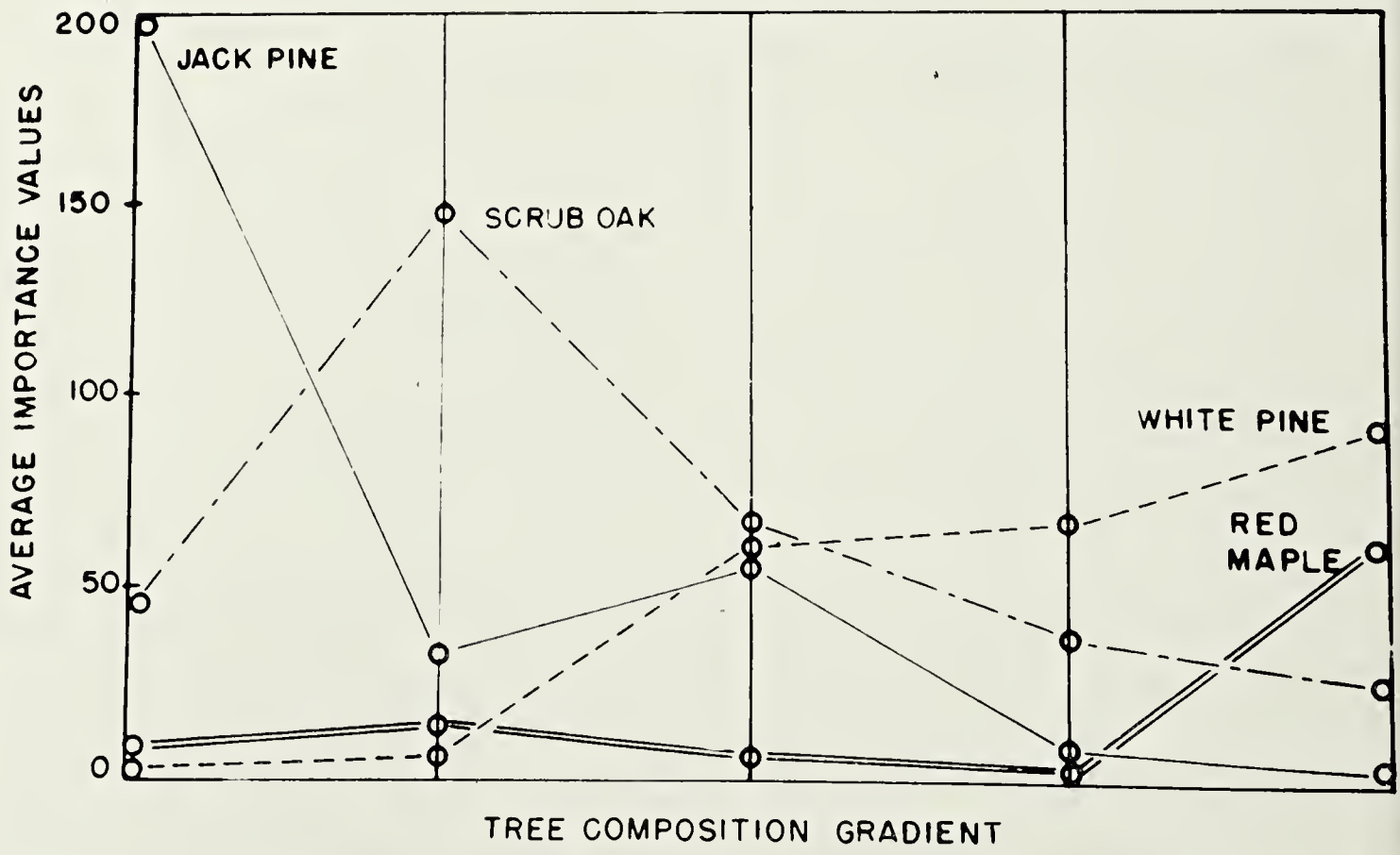


FIGURE 2. Arrangement of the eight most important tree species along the Tree Composition Gradient. The ordinate scale is average importance values and the abscissa is divided into five, 225 unit segments.

The Presence Index value for this stand is 150.0. A stand must have only prairie indicators present to result in an index value of 100, and similarly, a stand to have an index value of 300 must possess mesic boreal indicators only. An index value of 200 can be arrived at if a stand has only dry boreal indicators present or if the arrangement of indicators is symmetrical, such as 3–4–3, 1–5–1, 4–0–4, etc.

Results and Discussions

Species behavior along the Tree Composition gradient: As was stated, the thirty-three stands with boreal understories were arranged on the basis of tree behavior as derived from the study of the northern upland forests (Brown and Curtis, 1952). The compositional index number for the sand plain communities included here range from 328 to 1553. The theoretical limits for the northern upland forest are 300 to 3000. The communities included by Brown and Curtis (1952) in their study of the entire northern forest range from 326 to 2990. Figure 2 shows the phytosociological behavior of the eight most important tree species along the Tree Composition gradient. These data, expressed as average importance values, were calculated from the stands in each of five, 225 unit segments. As can be seen, the results indicate that these forests form a vegetational continuum with a progressively changing composition.

The most mesic vegetation in the central Wisconsin sand plain area is found along the river terraces, but these were not included in this study. Such areas are few in number and occupy a small percentage of the total area. On these wet bottamlands, one finds such species as basswood (*Tilia americana*), American ash (*Fraxinus americana*), river birch (*Betula nigra*) and rarely sugar maple (*Acer saccharum*). On distinctly upland areas, the most mesic vegetation to be found is composed of red maple, red oak and white pine. The most pioneer tree species appears to be jack pine.

An interesting comparison, demonstrated by six of the tree species in Figure 3, is made when the average importance values of the trees in central Wisconsin are compared with similar values of the same species in northern Wisconsin. In this comparison, the northern tree compositional gradient has been divided into twelve, 225 unit segments. From this comparison it appears that jack pine in central Wisconsin (in stands with boreal understories) behaves similarly to the jack pine in northern Wisconsin. Scrub oak is also similar in both regions, but it is apparent that scrub oak does not reach the high level of importance in northern Wisconsin that it does in the central Wisconsin sand plain area.

White pine, in the sand plain area, appears to approach the phytosociological behavior of white pine in northern Wisconsin. The lack of comparable mesic stands in the sand plain area, however,

prevents the full expression of a normal or Gaussian curve such as white pine displays in northern Wisconsin. If one maintains the idea that the upland sand plains of central Wisconsin are not currently capable of supporting stands which are more mesic (such as sugar maple-basswood), then the behavior curve representative of white pine in central Wisconsin can not approach a normal or two-

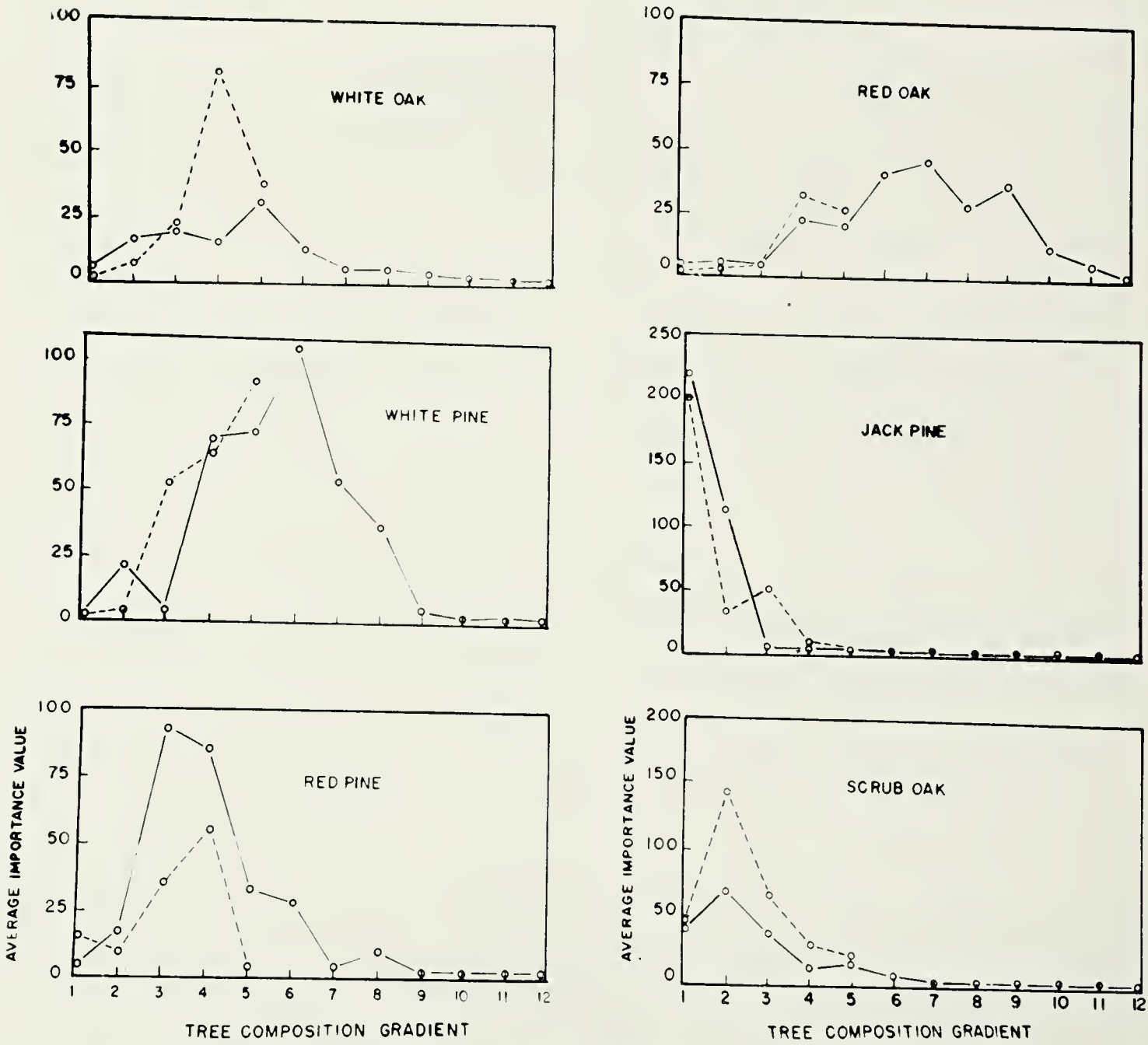
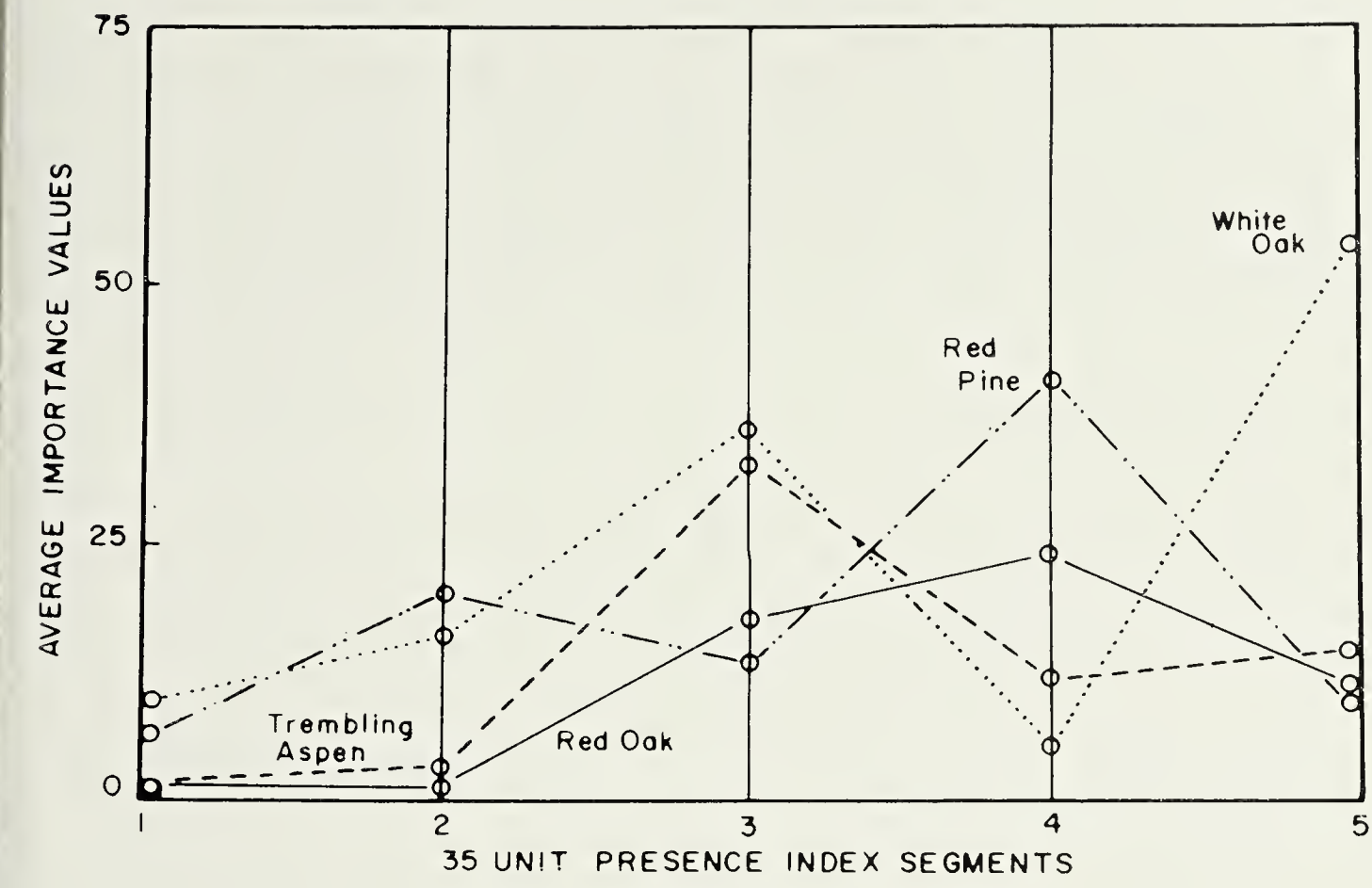


FIGURE 3. Comparison of the phytosociological behavior of six tree species in the central Wisconsin sand plain (dashed line) and in northern Wisconsin (solid line). The ordinate scale is average importance values and the abscissa is divided into 225 unit segments.

tailed arrangement. At the present time, there is insufficient evidence concerning the successional or terminal position of white pine in the central Wisconsin sand plain area.

The phytosociological behavior curves for red pine and white oak (*Quercus alba*) present an interesting situation. The red pine in the sand plain area does not come close to reaching the level of importance values which red pine exhibits in northern Wisconsin. Con-



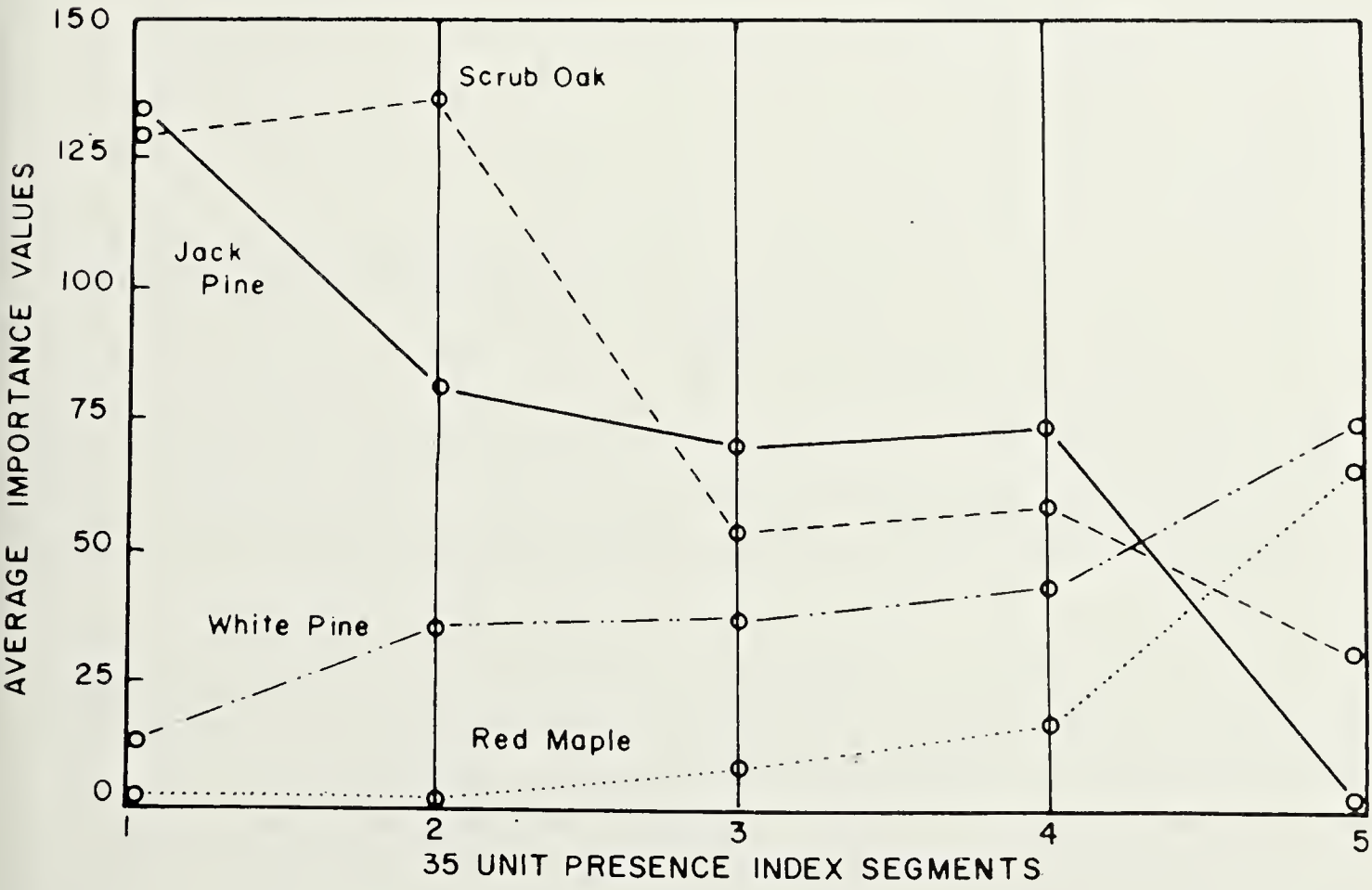


FIGURE 4. Arrangement of the eight most important tree species along the Presence Index gradient. The ordinate scale is average importance values and the abscissa is divided into five, 35 unit Presence Index segments.

versely, white oak expresses much higher importance values in the sand plain area than it does in northern Wisconsin communities. The positions of the peaks, however, are similar in both instances. These data seem to suggest that the absence of stands, in the sand plain area, containing large amounts of red pine is related to the logging history of the region. If red pine stands were cut at such a time when white pine was not large enough to be of commercial

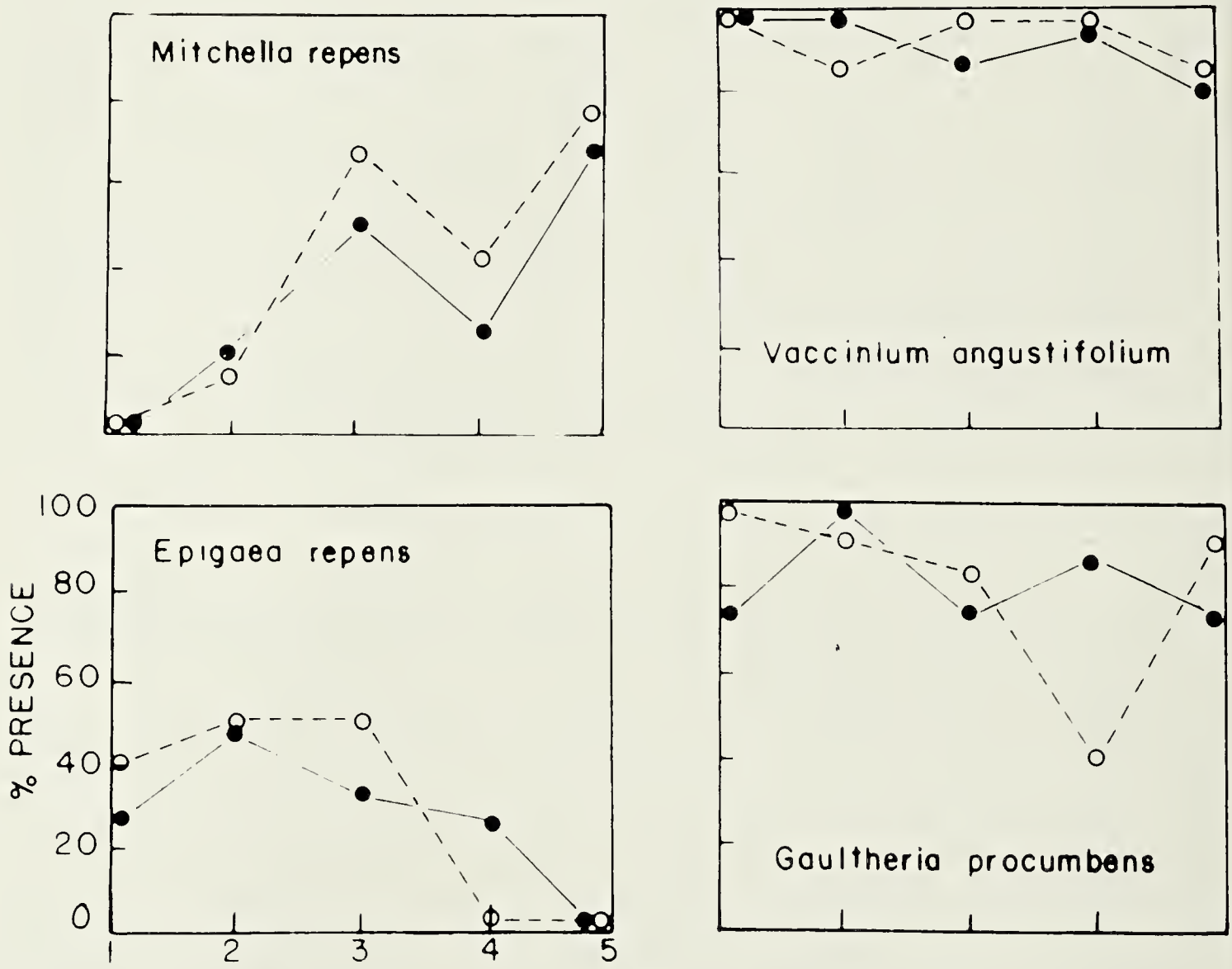


FIGURE 5. Comparison of the phytosociological behavior of four ground-layer species when arranged along the Tree Composition gradient (dashed line) and the Presence Index gradient (solid line). The ordinate is percent presence and the abscissa is divided into five equal units representing both ordination gradients.

value, it is very likely that white oak, which is essentially equal to red pine in its ecological tolerance, was permitted to reach higher importance levels in these cut-over red pine stands.

Species behavior along the Presence Index gradient: The Presence Index value was calculated for all forty-nine central Wisconsin sand plain communities. The theoretical range for this index, as was mentioned, is from 100 to 300; the actual range of values is from 122.2 to 271.4. Figure 4 shows the arrangement of the eight most important tree species along the Presence Index gradient. The

Presence Index gradient has been partitioned into five segments of 35 units each; the average importance values of each species in each segment has been plotted.

Comparing the phytosociological behavior of these tree species along both community ordinations, the Tree Composition gradient and the Presence Index gradient, it is evident that the relative positions of the behavior curves of these species are rather similar, that is, the vegetational continuum resulting from the tree arrangement along the Presence Index gradient is very much like the continuum resulting from the tree arrangement along the Tree Composition gradient. Along the Presence Index gradient, jack pine and scrub oak are rather dominant in that portion of the gradient where the prairie and dry boreal understory is well developed. White pine and red maple are most prevalent and reach their highest level of importance in that portion of the Presence Index gradient representative of a well-developed mesic boreal understory.

The phytosociological behavior of the ground-layer species is, in many instances, similar along both ordination gradients. Figure 5 shows the behavior curves for four ground-layer species which show close agreement along both gradients.

It is of particular interest that although the two methods of forest community ordination discussed here were developed on the basis of different criteria, in one case tree composition and in the other understory vegetation, both result in similar phytosociological descriptions of the vegetation in the central Wisconsin sand plain area.

Further comparison of these two methods of phytosociological ordination can be made by plotting other stand characteristics along these two gradients. Data relating to shrub cover, canopy cover and tree density have been plotted along the gradients and are shown in Figures 6 and 7. Examination of these graphs indicates that the shrub cover increases from left to right along both gradients. This increase in shrub cover is reflected by the decrease in the average shrub distance from left to right along the gradients. Similarity in the two ordinations is also shown by the general increase in tree canopy cover from left to right along both gradients.

There is not the same degree of similarity shown between the two gradients however when tree density (number of trees per acre) is plotted along them. Along the Presence Index gradient, there is a general increase in the tree density from left to right; along the Tree Composition gradient, there is a trend for the tree density to decrease from left to right. These data are rather confusing at first sight, particularly when tree canopy cover data are taken into consideration. Perhaps the most important single factor contributing to this apparent anomaly is the existence of two types

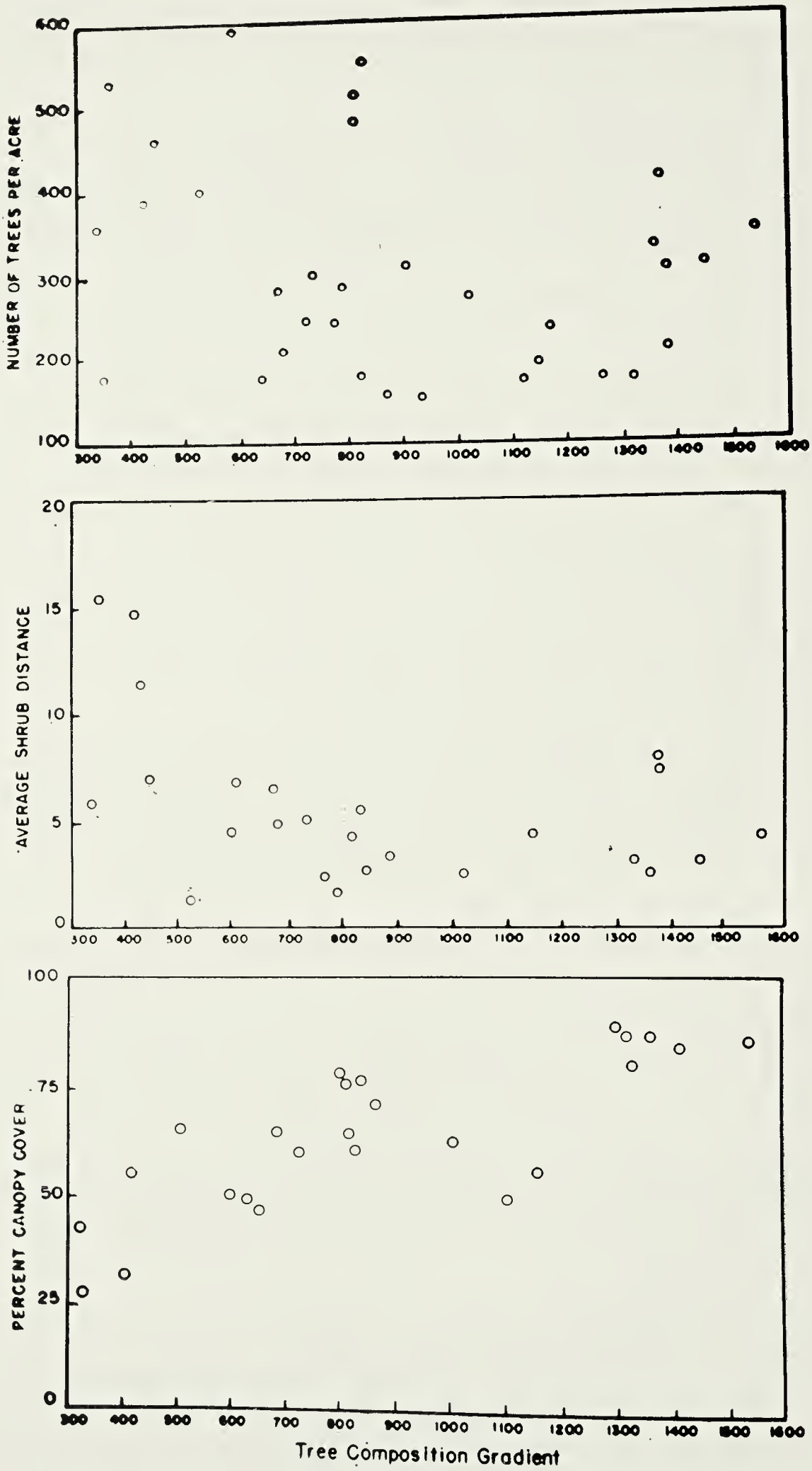
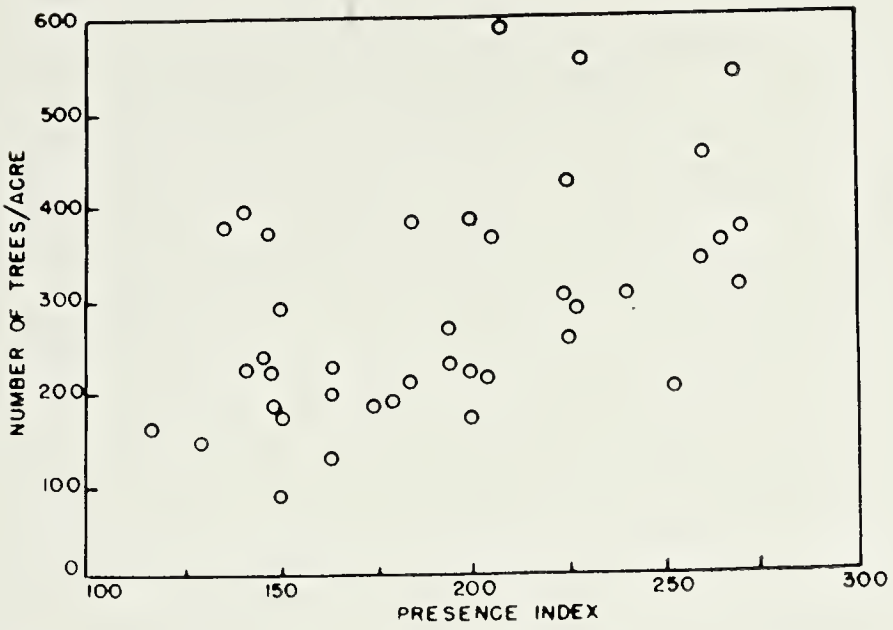
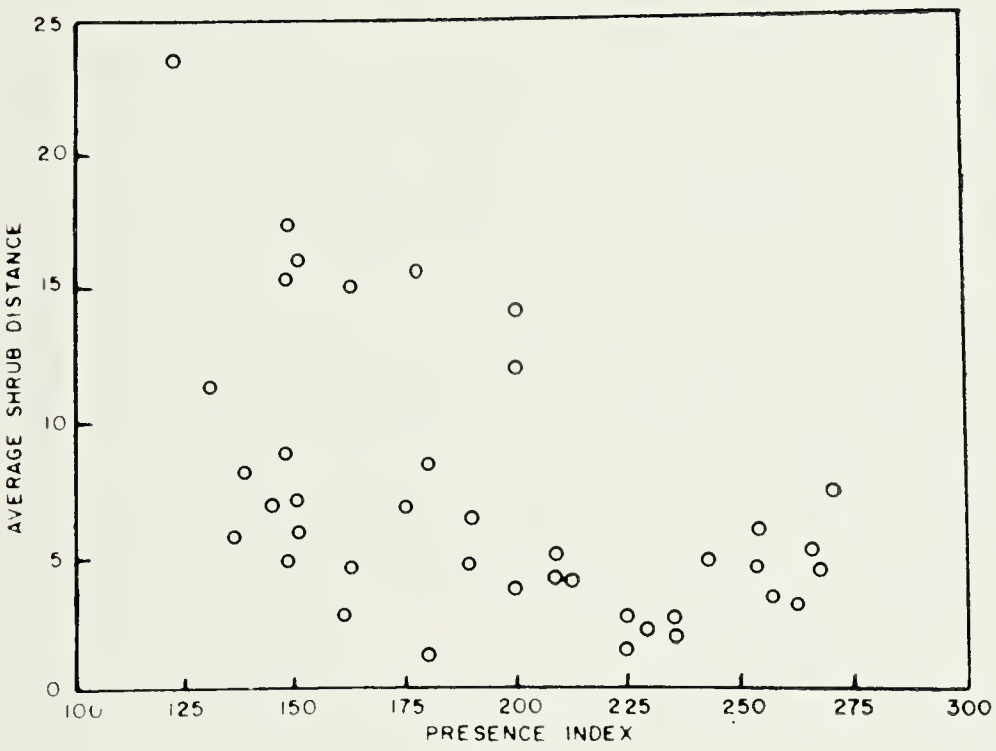


FIGURE 6. Graphic representation of changes in tree density, shrub cover and tree canopy cover along the Tree Composition gradient. Each circle in each graph represents data from one stand.





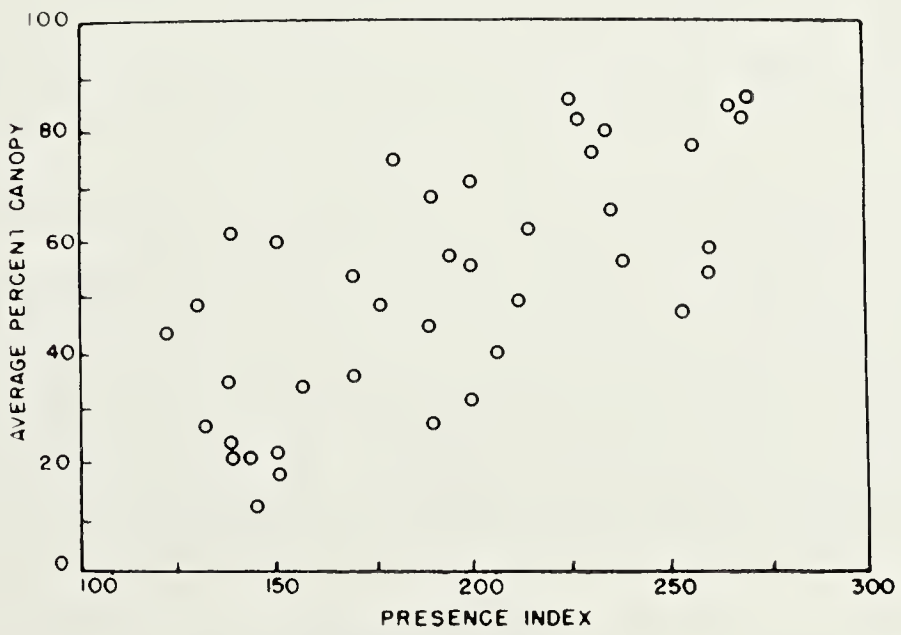


FIGURE 7. Graphic representation of changes in tree density, shrub cover and tree canopy cover along the Presence Index gradient. Each circle in each graph represents data from one stand.

of jack pine communities in the sand plain area. The existence of two types of jack pine communities was suggested earlier in this report; one type of jack pine stand has relatively low tree density and a corresponding low tree canopy cover. Jack Pine stands of this type often possess many open-grown individuals and have a prairie understory. As stands of this type become more mesic, there is an increase in both tree density and tree canopy cover.

The second jack pine community type is characterized by a high tree density, but possesses a relatively low tree canopy cover. The individual jack pine trees in this type have very small canopies which do not over-lap to any great degree, and thus under these circumstances a rather high light penetration is permitted. In addition to these features, the jack pine communities of this second type usually possess non-prairie understories. The presence of dry boreal and mesic boreal indicator species in these stands results in Presence Index values for these stands between 200 and 225.

The differences in the origin and characterization of these two types of jack pine communities are probably related to the fire history of the region. It is thought that jack pine stands of the first type were maintained in an open condition by periodic fires. Periodic fires would be conducive to the maintenance of a prairie understory as well as prevent stands of high tree density from developing. It is suspected that jack pine stands of the second type arose as a result of one severe fire which was followed by a heavy stocking of even-aged jack pine seedlings. The absence of fire or the protection from later fires after this initial stocking would result in a dense jack pine community. The prairie flora would not have persisted beneath such a dense canopy, had it existed there originally; the more shade tolerant boreal species apparently found light conditions suitable. These jack pine stands are not as dense now as they were when first established, but they do have much higher tree densities than the jack pine communities which developed from openings.

From this interpretation, it is understandable why the tree density decreases along the Tree Composition gradient. Along the Presence Index gradient, these jack pine stands with boreal understories are placed at or near the middle of the gradient. The number of these jack pine stands with high tree density encountered in this study is not great, but their influence in the comparison of the two ordination methods is nevertheless noticeable.

Summary

1. In order to facilitate an accurate description of the winter range of white-tailed deer in the central Wisconsin sand plain area, quantitative study was made of the upland forest communities of

this region. This report is primarily devoted to a description and discussion of the phytosociological methods used in the ordination of the sand plain communities, with a presentation of the results of this ordination.

2. The data from a total of forty-nine forest communities were used in this phytosociological ordination. Because of the ecotonal nature of the sand plain area, as well as for other reasons discussed in this report, the forest communities were treated in two different ways. Forest communities which display boreal affinities in their understory vegetation were arranged in phytosociological order using the tree behavior as derived from the study of the northern Wisconsin upland forests. The second method of community ordination, called the Presence Index, was applicable to all forest communities in the sand plain area regardless of the understory type. The Presence Index method of community ordination uses the understory vegetation as a basis for ordering the stands.

3. The procedures used in ordering the sand plain communities on the basis of tree behavior and on the basis of understory vegetation are discussed in detail in this report.

4. An analysis of the phytosociological ordinations resulting from the two methods of community arrangement is made. In both instances similar vegetational description of the sand plain forests is achieved. The behavior of the tree species along the two community ordinations indicates that these sand plain forests form a vegetational continuum, with progressively changing composition.

5. Many of the ground-layer plants exhibit similar phytosociological behavior along both community ordinations. The close similarity of other forest community characteristics along both community arrangements strengthens the conclusion that similar phytosociological ordination of the central Wisconsin sand plain forests is possible by using either tree composition or understory species as a basis for ordering the communities.

6. The most pioneer forest community type found in the sand plain area is composed of jack pine. Pure stands of jack pine or stands composed of jack pine and scrub oak comprise about nine-tenths of the forest area in central Wisconsin's sand plain. The most mesic communities to be found on the upland sand areas are composed of white pine, red oak and red maple. These mesic communities occur infrequently and occupy a small percentage of the total sand plain area.

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FOREST COVER AND DEER POPULATION DENSITIES IN EARLY NORTHERN WISCONSIN

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Information located in government reports, early travel journals, and newspapers has been very important in the reconstruction of the history of the white-tailed deer (*Odocoileus virginianus*) in early northern Wisconsin. The literary researches and interpretations of Swift (1946), Schorger (1953) and Dahlberg and Guettinger (1956) have provided the foundation for many of the presently accepted ideas concerning the history of the deer in northern Wisconsin. From their analyses of the available historical literature, these writers seem to hold in common the belief that white-tailed deer were very rare or absent in much of northern Wisconsin prior to 1850, or before the advent of extensive logging and settlement. The lack of suitable summer deer range is thought to have been the major factor in limiting the deer to low population densities in northern Wisconsin, and that furthermore, the deer herd increased in size only after there was an increase in the summer deer range following removal of the mature forest communities by white man.

It seems evident that the mature upland forest communities composed of sugar maple (*Acer saccharum*)[2], yellow birch (*Betula lutea*), hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) which existed in northern Wisconsin prior to 1850 could not have provided satisfactory summer range for deer. Such forest communities which exist today are known to provide poor summer deer range. It is also clear that the great increase in the deer population, which reached an explosive peak in the 1880's, was a direct result of the extensive removal of merchantable timber throughout the northern portion of the state. There is considerable doubt, however, about the validity of the widely held idea that deer were rare in northern Wisconsin before the disturbance of the forests by white man.

In elaborating on this doubt concerning deer population densities in early northern Wisconsin, a question arises which is concerned with the actual nature of the forested landscape in northern Wisconsin before the cutting era. This question requires very close examination, as estimates of the number of deer originally inhab-

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[2] Nomenclature for plant species follows Gleason (1952).

iting northern Wisconsin have been based on the type of habitat which supposedly existed in early times. Estimates as low as 10 deer per square mile have been made (Dahlberg and Guettinger, 1956) for northern Wisconsin. If northern Wisconsin actually had been covered with a vast uninterrupted virgin forest, such a low estimate of deer density would probably be accurate. Such a forest, however, did not exist in northern Wisconsin. Generalized descriptions of the forest vegetation in northern Wisconsin prior to 1850 are available in many local descriptions. Some of the early accounts portray some parts of northern Wisconsin as being heavily forested (Roth, 1898; Irving, 1880; Sweet, 1880) ; in such areas only a low number of deer, if any, could have been supported.

In contrast to these reports, there are several very good descriptions which reveal that there were present, in northern Wisconsin and adjacent Upper Michigan, prior to 1850, extensive areas not covered with mature forests, but with pioneer and secondary forest communities composed of jack pine (*Pinus banksiana*), aspen (*Populous tremuloides* and *P. grandidentata*) and white birch (*Betula papyrifera*). Forest communities composed of these species are known to provide excellent summer deer range.

Two written accounts were made by Capt. T. J. Cram (1841, 1842), who traveled through northeastern Wisconsin while on a government assignment to survey the Wisconsin-Michigan border. In an area in the vicinity of the upper Menominee River, Cram (1841) describes the vegetation as follows:

> "All the timber which was once pine has been consumed by fire, as far as the eye can reach, all round on every side. The prospect is one of a broken landscape of barren hills, studded here and there with charred pine stubs with scarcely a living tree except the second growth of white birch and poplar."

Cram (1842) describes another area located near the Wisconsin-Michigan border:

> "These highlands are in the process, owing to the destructive ravages of fires, of fast approaching to prairie, such as exists in the southern and western parts of the Territory, and leave little doubt, in the mind of the close observer, of the cause of these prairies."

The mention of fires in these accounts by Cram is very significant. It is very likely that since there was no one in northern Wisconsin to control forest fires, those which did occur must have destroyed large areas of timber before they stopped. A statement by Aulneau (1736) indicates that Indians were responsible for some fires in the Lake Superior region.

> "I journeyed nearly all the way through fire and a thick stifling smoke, which prevented us from even once catching a glimpse of the sun. It was the savages who in hunting had set fire to the woods, without imagining, however, that it would result in such a terrible conflagration."

Fires, arising either from natural causes or through the intentional activities of Indians, would have created suitable summer deer range. Cram (1841) makes several references to deer in the northeastern part of Wisconsin, and in one particular instance he mentions that deer were present in great abundance and were hunted by Indians for winter food.

Another source of information relating to the forest cover in northern Wisconsin prior to 1850 is the written account of Dr. J. G. Norwood (1852), a professional geologist who taveled through northwestern and northcentral Wisconsin during the years 1847 and 1848. Although Norwood was particularly interested in the geology of northern Wisconsin, he made many references to the native vegetation. Of an area approximately twenty-five miles south of Fond du Lac (presently, Superior, Wisconsin), Norwood gives the following description:

> "A good deal of it is prairie, covered with wortleberry bushes (*Vaccinium*) and strawberry vines; while in the low grounds, hazel abounds. Small pines, birch and scrubby oak succeeded, with strips of sugar maple. From this point to Kettle River, the country presents a succession of small lakes, swamps, meadows and ridges, covered with birch and small pines."

From this description it is clear that such an area would provide very satisfactory summer deer range. Norwood also describes the area in the vicinity of the east branch of the Chippewa River (Iron County) as a sand barren with a few stunted pines and occasional patches of coarse grass being the only vegetation supported on the high ground.

Of the area between Lac du Flambeau and Trout Lake (Vilas County), Norwood states:

> ". . . the portage passes for some distances over a sand plain supporting a few scattering pines. The surface of the ground is literally covered with wintergreen."

At the end of this portage, Norwood states:

> "Trout Lake . . . is surrounded by drift hills, from 25 to 40 feet high, supporting a sparse growth of small pines and birches."

At the headwaters of the Wisconsin River (northeastern Vilas County), Norwood describes the area as follows:

> "The country . . . is open, bearing thickets of small birch, a few stunted pines scattered through them. Occasionally, a solitary large pine was seen standing in a sandy knoll, 20–30 feet above the level of the river. Below the last rapids the country is made up of sand, supporting tolerably good growths of pine, birch and aspen."

Continuing his travels down the Wisconsin River, Norwood describes an area in northern Oneida County.

> "A narrow strip of small pines line the banks of the river at intervals; but, as you recede into the country, there are few trees of any size to be seen. Clumps of very small birch and pine are scattered over it."

Additional descriptions of parts of northern Wisconsin are found in an account made by Owen (1848) who was a government geologist. Owen gives this description of an area in Douglas County in northwestern Wisconsin.

> "The whole extent of the upper rapids of the Brule (River) must be seven or eight miles by the river; they are not so continuous as those below, having in some places nearly a mile of still water intervening. At their head are open woods of pine and aspen poplar and on the southwest large tamaracks."
>
> "The river now expands itself into a double or triple its former width, with very little current. It is bounded by low ridges, with a growth of small pines and aspen poplar."

Also in Douglas County, at the headwaters of the St. Croix River, Owen states:

> "The shore at the northern extremity is low, but on the east and west it is bounded by ridges twenty to thirty feet high, on which the growth is chiefly birch."

In the vicinity of Lac Court Oreilles (Sawyer County), Owen describes the area as follows:

> "The country becomes more open, the dense pine forest gives place to a more stunted growth of evergreen and aspen. The general face of the country, however, for four or five miles before reaching the lake is very little elevated above high water mark and it supports only such growth as flourish in swamp ground. A few stunted and half decayed pine were the only trees visible."

Also in Sawyer County, Owen states:

> "The Namekagon river is about fifteen to twenty paces wide, with banks from eight to twelve feet high. The prevailing growths are pine and birch, usually of small size. The undergrowth is level and the wood open."

Schoolcraft (1855) gives a short description of an area located near the point where the Montreal River flows into Lake Superior. This description was made in 1820 in an area now part of Iron County.

> "A bank of red clay, of twenty or thirty feet in depth, overlays the rock, covered with a young growth of birch and poplar. There are no large, or apparently old trees seen along this part of the coast."

Whittlesey (1849) supplies some descriptions of the south shore of Lake Superior. He describes the vegetation of an area in Upper Michigan, on the north side of the Penoki range, as follows:

> "The timber is very close, though not high, and the soil appears to be good. It produces in the moist places native grass of good quality, and on the dry portions dwarf pine, aspen, balsam and birch."

Whittlesey also describes a portion of the area between the Bad River and Brule River.

> "In the central part of the tract under notice the surface and the mass of the hills or mountains are composed of soft materials, sand and light gravel, producing large white and yellow pines, and in places where sand predominates, large fields of huckleberries, growing among scattered cypress and dwarf pines, many miles in extent."
>
> "On the dry portions of the red clay, which is here, as usual, on Lake Superior, but little rolling, we find the aspen, birch and white pine. On the sandy, huckleberry lands, where pine is of moderate thickness, large districts have been overrun with fire, leaving a vast forest of blackened trunks, producing upon the mind a vivid impression of solitude and desolation."

Outside of the state of Wisconsin proper, but in the Lake States region, Agassiz (1850) supplies some interesting descriptions of the native vegetation. In the vicinity of the Michipicotin River (Ontario), Agassiz describes the forests as follows:

> "Contrary to my expectations, and to what had been told me of the country, the forests are not remarkably dense and there is rarely any difficulty in penetrating except the cedar swamps. We never penetrated far into the interior, which is said to be in general thinly wooded."

Agassiz also gives a description of the landscape in the vicinity of St. Ignace (Michigan), observed by him while making a portage.

> "After proceeding some distance through rank grass and undergrowth, we came to the bluff, which was a very stiff fifteen minutes climb. This brought us onto a table land covered principally with scrub pine, which is much like our common pitch pine. This table land was dry, sandy and thinly covered with wood, with wide openings covered only by scanty, withered grasses. The fire had been through in several places and here woodpeckers and black flies abounded. This seems, from what we heard, to be the general characteristic of the interior except on the water courses."

There is some historical information (Bersing, 1956) which indicates that deer were captured by Indians using fences or corrals built specially for that purpose. The word "Mitchigan" is an Ojibwa word meaning "a wooden fence to catch deer near its banks" and refers to the practice of building fences near lakes and rivers to capture deer. A body of water in Vilas County, called Fence Lake, received its name as a result of the fences built there by Indians for capturing deer. It is not thought probable that Indians would have built such fenses to capture only a few deer.

Foster and Whitney (1850) describe the use of fences by Indians in capturing deer in Upper Michigan:

> "Within this township the Machigamig (River) receives from the right its two principal tributaries, the Mitchikau or Fence river, and the Nebegomiwini or Night-watching river. The origin of these names, as explained by our voyageurs, was this: At one time the deer were observed to be very numerous about the mouth of the former river, and the Indians, to

> secure them, built a fence from one stream to the other. They (the deer) would follow rather than overleap this barrier, until they were entrapped by their concealed foe. This method of capturing deer is also practiced on the Menominee."

Foster and Whitney also describe the landscape of an area near the Brule and Machigamig Rivers in Upper Michigan:

> "Fires have swept through the woods which once covered the surface, so effectively as to leave hardly a living tree. Blackened trunks rise up on every side as far as the eye can reach. Over this dreary waste the birch and aspen have sprung up."

A description of wind damage near Ontanagon, Michigan, is also supplied by Foster and Whitney:

> "Thunderstorms of great violence are not unusual; and the large tracts of prostrate timber frequently met with in the forests, and known as 'windfalls', indicate the path of the tornado."

The information given in these accounts permits one to conclude, with good reason, that large areas existed in northern Wisconsin and Upper Michigan prior to 1850 which were not in mature forest. There are, of course, other historical accounts which describe some parts of northern Wisconsin as covered with mature forests; even the writers listed above describe some areas as having mature forests. To achieve the most accurate picture of the forest communities in early northern Wisconsin, it is necessary to combine all the vegetation descriptions which are available.

There seems little doubt that the early northern Wisconsin landscape was actually a mosaic of forest community types, with mature, secondary and pioneer communities interspersed. The intervention of natural catastrophes, particularly fire, prevented the development of a vast, unbroken virgin forest. From what is presently known about the summer range requirements of the white-tailed deer, any of the areas described in the historical accounts given in this paper would have provided excellent summer deer range. If early deer population densities are to be estimated from habitat conditions, and this seems entirely justifiable, then the evidence supports the idea that deer could not have been scarce in nonrthern Wisconsin prior to 1850. It is more likely that deer were "rare" only in a relative sense, compared with the abnormally high densities which built up after extensive cutting, man-made fires and predator control.

The original land survey records for the northern Wisconsin area provide some idea of the general proportion of forest community types at about 1850 (Curtis, 1959). Approximately 2,340,000 acres were covered with pine barrens; about 2,269,500 acres were covered with pine forests; mesic hardwood forests covered about

11,741,000 acres, of which approximately 1,000,000 acres was in aspen. If it is considered that the pine barrens, pine forests and aspen forests provided satisfactory summer deer range, then nearly 5.5 million acres of summer range were present.

The original land survey records also reveal that there were approximately 2,241,000 acres covered with lowland forest communities in northern Wisconsin. Although no differentiation of types was made in these survey reports, forests composed of tamarack (*Larix laricina*), black spruce (*Picea mariana*), balsam fir (*Abies balsmaea*), white cedar (*Thuja occidentalis*) and black ash (*Fraxinus nigra*) were the most common. Christensen's review (1954) review of the historical accounts relating to the winter deer range in northern Wisconsin has revealed that white-tailed deer have used lowland swamp communities, particularly those dominated by white cedar, from the earliest times for which historical records are available. There is no evidence that the winter yarding behavior of the deer is a recently acquired characteristic; it is very probable that the deer have always possessed this behavior. There was apparently a sufficient number of lowland swamp communities in early northern Wisconsin to meet the winter range requirements of the deer which were present at that time. Prior to 1850, the deer population density in northern Wisconsin could not have been limited by the winter range. More recently, however, the winter range in northern Wisconsin has played a very important role in limiting the deer density. The area of white cedar communities has decreased greatly. The present acreage of white cedar swamps is approximately 182,000 acres (Wisconsin Forest Inventory, 1958); if it is considered that white cedar occupied but one-third of the lowland areas in northern Wisconsin in 1850 (ca. 747,000 acres), which may be taken as a minimum, the decrease of cedar swamps amounts to more than 75%.

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NOTES ON SOME RARE PLANTS OF WISCONSIN—I

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In a survey of the vascular plants of the "Driftless Area" being made by the writer, several species have been collected that appear to be rare in Wisconsin. It is felt that information concerning these species should be placed on the record for interested persons. The species are here presented with notes on their known distributions in Wisconsin. In some instances, mention is made of associated species to indicate more clearly the nature of some of the habitats. Although family names are not included, the species are listed by families in Englerian sequence.

The nomenclature used is largely that of *Gray's Manual of Botany, 8th Ed.* Introduced and/or adventive species are indicated by an asterisk. Numbers not preceded by a name indicate the author's collection numbers. Vouchers for all of these collections are, or will be, deposited at the herbarium of the State University of Iowa. Many of the collections are, or will be, deposited at the herbarium of the University of Wisconsin.

The author wishes to thank Dr. Hugh H. Iltis, curator of the herbarium of the University of Wisconsin (UW) and Mr. Albert M. Fuller, curator of the herbarium of the Milwaukee Public Museum (Milw) for permission granted to examine pertinent herbarium specimens. Grateful acknowledgment is made to Dr. Robert F. Thorne of the Department of Botany, State University of Iowa, under whose direction the author's study of the "Driftless Area" is being made. The author is also grateful for funds supplied by the National Science Foundation which alleviated much of the expense of the field work.

Asplenium platyneuron (L.) Oakes, ebony spleenwort, was reported only from northwestern Dane County (UW and Milw) by Tryon, Fassett, Dunlop and Diemer (1940) in "The Ferns and Fern Allies of Wisconsin". It was collected by this writer on June 20, 1956, on a dry sandstone outcrop in a woods bordering County Trunk D, Section 6, Burns Township, La Crosse County, 1609.

Pellaea atropurpurea (L.) Link, purple cliff-brake, was reported only from Sauk County (". . . only on sandstone cliffs near Prairie du Sac") by Tryon, Fassett, Dunlop and Diemer (1940). It is represented in the herbarium of the University of Wisconsin by collec-

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tions from four stations in southern Sauk County. Recent field work in western Wisconsin revealed the presence of this cliff-brake in Vernon County where it grows on exposed sandstone ledges of a Mississippi River bluff near Stoddard, Section 21, Bergan Township, T. G. and R. T. Hartley 1040, July 1, 1956.

Potamogeton diversifolius Raf. was reported from Grant (UW), Crawford, Juneau (UW) and Eau Claire (Milw.) counties by Ross and Calhoun (1951). A more recent collection is from Price County, D. W. Swindale, September, 1952 (UW). In 1956 this species was collected in shallow water of a small pond formed by Sand Creek, Section 29, Melrose Township, Jackson County, 1586, July 20, and 2086, August 8.

Potamogeton vaseyi Robbins is apparently quite rare in Wisconsin. It was reported only from Juneau (UW and Milw), Oneida (UW and Milw), Portage (UW and Milw) and Sauk (UW and Milw) counties by Ross and Calhoun (1951). A recent collection from Lincoln County by F. C. Seymour 14919, September, 1952 (UW), is labeled as this species although sterile and seemingly of uncertain identity. On July 10, 1956, this pondweed was collected in shallow water of Lake Onalaska, Onalaska Township, La Crosse County, 1831.

Other pondweeds collected in 1956 in Lake Onalaska (an impoundment of the Mississippi and Black rivers above U. S. Lock and Dam No. 7) were *Potamogeton crispus* L., 1828, *Potamogeton nodosus* Poir., 1830, *Potamogeton pectinatus* L., 1823, *Potamogeton pusillus* L., 1826, *Potamogeton richardsonii* (Ar. Benn.) Rydb., 1829 and *Potamogeton zosteriformis* Fern., 1825.

**Agropyron desertorum* (Fisch.) Schult was not reported in "The Grasses of Wisconsin" by Fassett (1951) and is apparently a new record for the state. This is a species that has been introduced into western United States and is spreading eastward. It was collected on a rather weedy railroad right-of-way between West Salem and Bangor, Section 1, Hamilton Township, La Crosse County, Hartley and Orlin Anderson 996, June 30, 1956.

Aristida oligantha Michx. was reported for Wisconsin by Fassett (1951) only from Dane (UW and Milw) and Milwaukee (UW and Milw) counties. On August 30, 1956, this species was collected on a dry, sandy prairie bordering a railroad between North La Crosse and Onalaska, Section 17, Campbell Township, La Crosse County, 2781.

**Buchloe dactyloides* (Nutt.) Engelm., buffalo-grass, was not reported for Wisconsin by Fassett (1951) and is apparently a new record for the state. It is a western species that was probably brought into Wisconsin via railroad cars. A sizable patch of it was discovered on August 2, 1956, along a railroad track in North La

Crosse, La Crosse County, 1996. Growing but a short distance away along the same track was another western grass, *Distichlis stricta* (Torr.) Rydb., which is discussed below.

**Distichlis stricta* (Torr.) Rydb., alkali-grass, was not reported by Fassett (1951) and is apparently a new record for Wisconsin. This adventive western species was collected on a sandy railroad right-of-way in North La Crosse, La Crosse County, 1991, August 2, 1956. Probably brought in on freight cars from the West, a rather large colony of this grass has formed along the tracks.

Oryzopsis canadensis (Poir.) Torr. was reported for Wisconsin only from Vilas (Milw) and Clark (Milw) counties by Fassett (1951). In 1958 three new stations were added for this species in Wisconsin: low, sandy woods bordering Town Line Flowage, Section 4, Millston Township, Jackson County, 4055, June 21; rather low, sandy woods bordering Little Bear Flowage, Section 8, Millston Township, Jackson County, 4733, July 19; dry, sandy woods bordering Roche a Cri Creek, Section 22, Big Flats Township, Adams County, 5627, August 23.

Poa sylvestris Gray was reported by Fassett (1951) as possibly occurring in two Wisconsin counties. That report was based on an immature specimen collected near Viroqua (Vernon County) by Hansen in 1929 (UW) and an older collection by Lapham labeled "Milwaukee". Now there are two well-substantiated stations for this grass in Wisconsin: Spring Grove maple woods, Section 29, T 1 N, R 9 E, Green County, G. Struik, John T. Curtis and H. C. Greene, May 31, 1956 (UW); at the moist base of a wooded ravine bordering Bohemian Valley, Section 25, Washington Township, La Crosse County, 732, June 24, 1956.

The steep, north- and east-facing wooded slopes and ravines bordering Bohemian Valley provide one of the more interesting botanical sites known to this writer in Wisconsin. Besides *Poa sylvestris*, other rare or otherwise interesting species collected on those slopes in 1956 and since include *Equisetum scirpoides* Michx., 740, *Athyrium pycnocarpon* (Spreng.) Tidestr., Hartley and Alvin M. Peterson 5422, *Camptosorus rhizophyllus* (L.) Link, 763, *Cryptogramma stelleri* (Gmel.) Prantl, Hartley and Peterson 2198, *Dryopteris goldiana* (Hook.) Gray, 725, *Milium effusum* L., 767, *Oryzopsis asperifolia* Michx., Hartley and Peterson 6402, *Carex albursina* Sheldon, 756, *Carex digitalis* Willd., 759, *Carex plantaginea* Lam., 731, *Carex pedunculata* Muhl., Hartley and Peterson 6403, *Carex scabrata* Schwein., 760, *Luzula acuminata* Raf., 762, *Erythronium americanum* Ker, Hartley and Peterson 6400, *Polygonatum pubescens* (Willd.) Pursh, 750, *Trillium grandiflorum* (Michx.) Salisb., Hartley and Peterson 6401, *Habenaria hookeri* Torr., 737, *Orchis spectabilis* L., 738, *Dicentra canadensis* (Goldie) Walp., Hartley and

Peterson 6397, *Dentaria laciniata* Muhl., Hartley and Peterson 6398, *Hamamelis virginiana* L., 680, *Acer spicatum* Lam., 728, *Viola pubescens* Ait., 743, *Dirca palustris* L., 747, *Circaea alpina* L., 734, *Sanicula trifoliata* Bickn., 742, *Hydrophyllum appendiculatum* Michx., 726, *Conopholis americana* (L.) Wallr., Hartley and Peterson 2186 and *Sambucus pubens* Michx., 730.

Carex backii Boott was collected at the dry, sandy border of an upland woods near the Black River, Section 9, Holland Township, La Crosse County, Hartley, R. F. Thorne, H. H. Iltis, *et al* 554, June 14, 1956. This sedge appears to be quite rare in Wisconsin. It is represented from the state by only three other collections: near Rocky Arbor Roadside Park, Juneau County, J. H. Zimmerman 3195, July 1, 1950 (UW) ; a specimen that appears to be this species from Blue Mounds, Dane County, T. J. Hale, collected in 1860 (UW) ; Sturgeon Bay, Door County, Charles Goessl, June 11, 1916 (UW).

Carex davisii Schwein. & Torr. is now known from five Wisconsin counties. Previous collections are as follows: opposite Sauk City in Dane County, J. J. Davis, June 11, 1928 (UW) ; Rock County, J. P. Lathrop, before 1900 (UW) ; near Browntown, Green County, J. J. Davis, June 23, 1927 (UW). Recently this species has been collected at two stations in western Wisconsin: alluvial woods bordering the Black River in Section 9, Holland Township, La Crosse County, 966, June 29, 1956; McGilvray Bottoms alluvial woods bordering the Black River, Section 31, Caledonia Township, Trempealeau County, 442, June 10, 1956.

The McGilvray Bottoms area has some of the richest alluvial woods this writer has seen in Wisconsin. Other sedges collected there in 1956 include *Carex blanda* Dew., 441, *Carex bromoides* Schkuhr., 565, *Carex cephaloidea* Dew., 438, *Carex crinita* Lam., 430, *Carex cristatella* Britt., 1307, *Carex gracillima* Schwein., 436, *Carex grayii* Carey, 420, *Carex grisea* Wahl., 417, *Carex haydenii* Dew., 432, *Carex intumescens* Rudge., 443, 570, 1288, *Carex lupulina* Muhl., 1313, *Carex muskingumensis* Schwein., 606, 1293, *Carex normalis* Mack., 434, *Carex rosea* Schkuhr., 568, *Carex scoparia* Schkuhr., 569, *Carex stipata* Muhl., 437, *Carex stricta* Lam., 433, *Carex tenera* Dew., 1309, *Carex tribuloides* Wahlenb., 605, 1305, *Carex tuckermani* Boott, 440, *Carex typhina* Michx., 418 and *Carex vesicaria* L., 431.

**Carex spicata* Huds. is a naturalized species (native of Eurasia) that appears to be a new record for the state of Wisconsin. It was collected in a recent clearing in an upland woods on Miller Bluff, Section 10, Shelby Township, La Crosse County, 1223, July 7, 1956. Inasmuch as several large clumps of this sedge were seen growing in the clearing, it is seemingly well established.

Carex sychnocephala Carey appears to be rare in Wisconsin. A search of the University of Wisconsin and Milwaukee Public Museum herbaria revealed only two Wisconsin collections of this rather distinctive looking sedge: moist, sandy soil near Oconto, Oconto County, Charles Goessl, August 13, 1916 (UW and Milw), and a collection by T. J. Hale, 1861, labeled "St. Croix" (UW). On August 23, 1958, this species was discovered growing abundantly on moist muck of the bed of recently-exsiccated Sand Lake, Sections 25 and 36, Plainfield Township, Waushara County, 5664. This station is just outside the "Driftless Area".

Some other interesting species collected in 1958 at Sand Lake include *Carex flava* L., 5655, *Cladium mariscoides* (Muhl.) Torr., Hartley and Thorne 5991, *Potentilla anserina* L., 5659 and *Lobelia kalmii* L., Hartley and Thorne 5993.

Scleria reticularis Michx. was not reported by Greene (1953) and is apparently a new record for the state of Wisconsin. This interesting nut-rush was found growing in great abundance on rather moist sand in the old bed of partially-exsiccated Silver Lake, Section 9, Quincy Township, Adams County, 5598, August 20, 1958, Hartley and Thorne 5884, August 31, 1958. It is an Atlantic coastal plain species that is also known from northwestern Indiana.

Other noteworthy species collected in 1958 on the extensive area of moist sand at Silver Lake include *Panicum philadelphicum* Bernh., 5600, *Cyperus erythrorhizos* Muhl., 5571, Hartley and Thorne 5895, *Fimbristylis autumnalis* (L.) R. & S., 5572, *Rhynchospora capillacea* Torr., 5593, Hartley and Thorne 5890, *Rhynchospora capitellata* (Michx.) Vahl, 5592, Hartley and Thorne 5881, *Scirpus purshianus* Fern., 5584, *Xyris torta* Sm., 5604, Hartley and Thorne 5882, *Juncus pelocarpus* Mey., 5578, Hartley and Thorne 5868, *Polygonum careyi* Olney, 5587, *Rotala ramosier* (L.) Koehne, Hartley and Thorne 5872, *Rhexia virginica* L., 5567, Hartley and Thorne 5878 and *Gerardia paupercula* (Gray) Britt., 5591. Two interesting species collected on the mat of sphagnum invading the east end of the old lake bed were *Drosera intermedia* Hayne, Hartley and Thorne 5899 and *Polygala cruciata* L., Hartley and Thorne 5885.

Draba nemorosa L. was previously known from only one station in Wisconsin: open, sandy soil at Marinette, Marinette County, Charles Goessl, June 25, 1916 (UW). On June 7, 1956, this mustard was collected on a dry, sandy plain on French Island, Section 6, Onalaska Township, La Crosse County, 342.

Other sand plants collected in 1956 on the dry, sandy river terrace on French Island include *Festuca octoflora* Walt., 324, *Eragrostis spectabilis* (Pursh) Steud., 1730, *Leptoloma cognatum* (Schult.) Chase, 2756, *Panicum commonsianum* Ashe. var. *euch-*

lamydeum (Shinners) Pohl., 1744, *Panicum meridionale* Ashe., 1739, *Panicum oligosanthes* Schultes var. *scribnerianum* (Nash) Fern., 338, *Paspalum ciliatifolium* Michx., 1728, *Sporobolus cryptandrus* (Torr.) Gray, 2765, *Carex festucacea* Schkuhr., 321, *Carex muhlenbergii* Schkuhr., 333, *Cyperus schweinitzii* Torr., 1741, *Polygonella articulata* (L.) Meisn., 2762, *Cycloloma antriplicifolium* (Spreng.) Coult., 1746, *Silene antirrhine* L., 325, *Prunus pumila* L., 331, *Crotalaria sagittalis* L., 1727, *Strophostyles helvola* (L.) Ell., 1743, 2753, *Strophostyles leiosperma* (T. & G.) Piper, 2757, *Euphorbia geyeri* Engelm., 1738,*Callirhoe triangulata* (Leavenw.) Gray (observed but not collected), *Helianthemum bicknellii* Fern., 2759, *Hudsonia tomentosa* Nutt., 1733, *Oenothera rhombipetala* Nutt., 1731, *Penstemon gracilis* Nutt., 341, *Plantago purshii* R. & S., 349, *Ambrosia psilostachya* DC., 2755, *Helianthus occidentalis* Riddell, 1734.

**Erysimum asperum* (Nutt.) DC., western wallflower, is adventive and apparently rare in Wisconsin. It was previously known from only three stations in the state: headwaters of the Marengo River, Bayfield County, Fred Knowlton, 1931 (Milw); Minong, Washburn County, Charles Goessl, July 6, 1917 (Milw); Marion, Waupaca County, Charles Gossl, June 3, 1915 (UW and Milw). In 1958 this wallflower was collected (two rather deformed specimens that were identified by Jacqueline Patman of the University of Wisconsin) on a gravelly railroad embankment bordering Wyalusing State Park, Grant County, 4479, July 11.

Callitriche deflexa A. Br. was not reported from Wisconsin by Fassett (1951) in "*Callitriche* in the New World" and appears to be an addition to the flora of the state. This southern species was collected on moist, shaded soil in an alluvial woods in the McGilvray Bottomland region along the Black River, Section 31, Caledonia Township, Trempealeau County, 1297, July 8, 1956. The tiny terrestrial plants formed dense mats about six inches in diameter.

**Callitriche stagnalis* Scop. is introduced (native of Europe) and apparently quite rare in Wisconsin. The only previous Wisconsin collection found in the two herbaria studied was one from Rhinelander, Oneida County, J. J. Davis, August 25, 1925 (UW). This collection was reported by Fassett (1951). In recent field work in the "Driftless Area" this species was discovered growing in swift-flowing water of Black Earth Creek, Section 32, Berry Township, Dane County, 5322, August 13, 1958. Immature specimens that also seem to be this species were collected in cold, swift-flowing water of the La Crosse River in the Camp McCoy Military Reservation, Section 23, Lafayette Township, Monroe County, 2487, August 19, 1956.

Other aquatics collected in the La Crosse River in and near Camp McCoy include *Sparganium americanum* Nutt., 2906, *Sparganium chlorocarpum* Rydb., 2443, *Potamogeton epihydrus* Raf., 2485, 2902, *Vallisneria americana* Michx., 2486, *Glyceria pallida* var. *fernaldii* Hitchc., 2903 and *Ranunculus aquatilis* L. var. *capillaceus* (Thuill.) DC., 2484.

Proserpinaca palustris L., mermaid-weed, has been collected in eight counties from the glaciated portion of Wisconsin: Dane (UW), Door (UW), Green Lake (UW), Lincoln (Milw), Manitowoc (Milw), Milwaukee (Milw), Oconto (Milw) and Racine (UW). Now this species can be added to the flora of the "Driftless Area". It was collected in a wet, sandy, roadside ditch bordering County Trunk H, Section 18, Cutler Township, Juneau County, Hartley and Thorne 6039, September 2, 1958.

**Mentha gentilis* L. was reported for Wisconsin only from Price County (UW) by Koeppen (1957). This introduced mint (native of Europe) is also known from La Crosse County where it was collected at the base of a wooded seepage slope bordering the Black River, Section 1, Holland Township, 1687, July 26, 1956.

Gerardia skinneriana Wood was reported as known in Wisconsin "only from the vicinity of Arena, Iowa County" by Salamun (1951). A new station for this species was discovered in 1958 when it was found growing along a dry margin of a sandy sphagnum meadow bordering Duck Creek, Section 26, Adams Township, Adams County, 5524, August 19, Hartley and Thorne 5918, August 31.

Other noteworthy species collected in the meadow along Duck Creek were *Lycopodium inundatum* L., 5495, *Xyris torta* Sm., 5536, *Aletris farinosa* L., 5513, *Polygala cruciata* L., 5516, *Hypericum kalmianum* L., 5494 and *Bartonia virginica* (L.) BSP., 5528. An interesting and rather rare fern, *Ophioglossum vulgatum* L., was collected in a similar meadow in northern Adams County in Section 21, Colburn Township, Hartley and Thorne 5996, September 1, 1958.

**Veronica persica* Poir., bird's eye, is a weed (naturalized from Eurasia) that appears to be quite rare in Wisconsin. It was reported from Marathon (UW), Milwaukee (Milw) and Sheboygan (UW) counties by Salamun (1951) and a 1957 collection indicates its presence in Madison, Dane County (UW). The distribution of this species in Wisconsin can now be extended to Grant County where it grows as a yard weed in Potosi, 5073, August 1, 1958.

**Plantago media* L., hoary plantain, is adventive from Europe and apparently rare in Wisconsin. Previous to 1956 this plantain appears to have been collected only once in the state: city of Sheboygan, Sheboygan County, Charles Goessl, July, 1903 (UW). On

August 30, 1956, it was collected on the La Crosse Country Club golf course near La Crosse, La Crosse County, 2787a.

Cirsium flodmani (Rydb.) Arthur appears to be a new record for the state of Wisconsin. Several plants of this thistle were found growing on dry, sandy soil bordering Wisconsin Highway 108, Section 31, Melrose Township, Jackson County, 2089, August 8, 1956.

**Hieracium floribundum* Wimm. & Grab., king devil, also appears to be a new record for Wisconsin. Spreading by stolons, a large colony of this European weed has become established along the edge of a sand blowout near County Trunk A, Section 9, Farmington Township, La Crosse County, 2308, August 14, 1956 and 4693, July 18, 1958.

Found growing with this king devil in 1958 was another weed that is rare in La Crosse County namely *Scleranthus annus L.*, 4667.

Summary

A total of twenty-six species is listed with comments on their distributions and habitats in Wisconsin. Sixteen of the species listed appear to be native of Wisconsin, three are native of western United States and adventive in Wisconsin, and seven are native of Europe or Eurasia and introduced and/or adventive in Wisconsin. Eight of the species listed appear to be new records for Wisconsin. Three of those appear to be indigenous to the state.

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DISTRIBUTION OF CENTRAL WISCONSIN FISHES*

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Three decades have elapsed since Greene (1935) made his survey of fish distribution in Wisconsin. Since then no comparable survey has been made. However, during the interim physical conditions of the terrain have been altered, seriously affecting the complexion of many Wisconsin streams. The crystal streams of yesterday have today assumed more somber hues. Land and water use is reflected in shifting fish species—substitutions in most cases toward less desirable forms.

The present paper is a contribution toward an evaluation of this change in Central Wisconsin. Greene's work will be used as the basis of comparison, especially in respect to the treatment of the individual species.

Acknowledgment is made to Prof. John Neess of the University of Wisconsin, to my colleagues John W. Barnes and William Clements, and to Conservation Warden Russell Christenson for their advice, information, statistical help and critical evaluation of the manuscript. Special thanks are due my son Kenneth who assisted daily in the field and without whose help the present study would not have been possible.

During the summer of 1958 a survey was undertaken of the fishes of seven streams in Central Wisconsin (Map 1). In all over 17,000 fish were handled, representing 53 species from 12 families.[1] A total of 59 stations were sampled.

The fishes were collected with electrofishing equipment where water conditions permitted. The C & H alternating current generator is rated for 1000 watts and delivers 120 volts at 8.5 amperes. It is powered by a 2½ horsepower, four-cycle Continental gas engine. This equipment was hauled behind in a small boat. The electrodes were fashioned from a heavy gauge copper wire forming an oblong hoop, 9.5 by 20 inches upon which ½ inch hardware cloth had been sweated. Where water conditions were too murky, a twenty-foot common sense minnow seine with six meshes per inch was employed.

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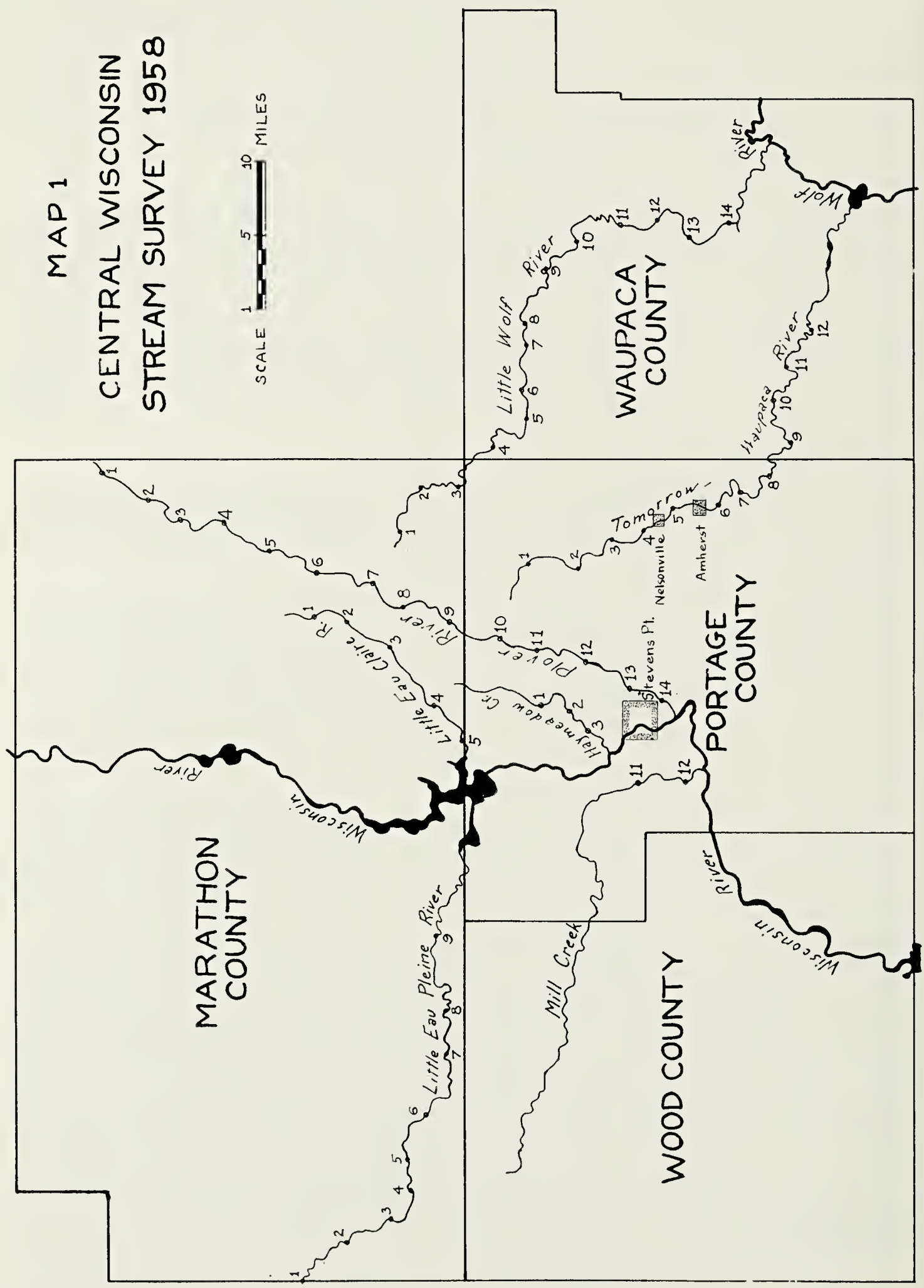
* Paper read at the 89th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

[1] The number of species indicated here in no wise implies completeness. As this paper goes to press an additional collection made at station 7 on the Tomorrow-Waupaca River in April, 1959, produced three species which had not been taken during the 1958 survey.


MAP 1
CENTRAL WISCONSIN
STREAM SURVEY 1958
SCALE 1 5 10 MILES
WAUPACA COUNTY
PORTAGE COUNTY
WOOD COUNTY
MARATHON COUNTY
Little Wolf River
Wolf River
Waupaca River
Tomorrow River
Nelsonville
Amherst
Plover
Stevens Pt.
Hiaymeadow Cr.
Mill Creek
Little Eau Pleine River
Eau Claire R.
Wisconsin River

Method of Sampling An Area

The stations worked on a stream were plotted from a map before the stream was visited. An attempt was made to set these stations as close as possible at three-mile intervals. These stations represented points of reasonable access. In a few instances they had to be revised slightly due to excessively deep water or obstacles which made it difficult to move the equipment to the water. The numbered points depicted on Map 1 are the areas actually worked.

Generally the boat was put in the water at the bridge or road end and the sample was taken upstream from this point. There was no uniformity as to the length of stream worked at each station. Generally the sample covered a distance of two to three hundred yards. The time and distance covered at each station was determined largely by the size and growth of the fish sample. In some cases one-half hour sufficed. At other stations after two hours, the sample, though deemed inadequate, was terminated. The survey was geared for making an average of three stations daily. Generally the sampling of a stream started with the downstream stations: e.g., stations 14, 13, and 12 of the Little Wolf River were sampled on July 21, and stations 3, 2, and 1 were completed on July 28.

A survey of the physical character of the water, bottom, etc., of each stream was taken on a particular day for all the stations. For the Little Wolf River this survey (Table II) was run on August 15. This data was purposely recorded in August, when low water and high air and water temperatures placed stresses on the physiological demands of many fish species.

Description of Study Area

The waters sampled were entirely within the counties of Marathon, Portage and Waupaca (Map 1). Five of the streams, the Little Eau Pleine River, Little Eau Claire River, Plover River, Haymeadow Creek and Mill Creek, lie in the Wisconsin River drainage basin. Their waters are carried via the Mississippi River into the Gulf of Mexico. On the other side of a narrow divide less than three miles from the Plover River arise the headwaters of the Little Wolf and the Tomorrow-Waupaca rivers. These meet the Wolf River in eastern Waupaca County. From here their water is carried into Green Bay and eventually out of the St. Lawrence River into the Atlantic Ocean.

The area was bisected by the continental glacier at the Wisconsin stage of glaciation (Martin, 1916). The Green Bay lobe extended over the southeast corner of Marathon County, the eastern half of Portage County, and over all of Waupaca County. The remaining area is part of the Older Drift and the Driftless Area. The Older

Drift refers to glacial deposits left by earlier ice advances, as the Illinoian, Iowan, Kansan and Nebraskan. The Driftless Area is reputed never to have had a covering of glacial ice (Martin, 1916).

Marathon county and the northern sections of Wood, Portage, and Waupaca Counties is underlain with granites and gneisses with some quartzites. Cambrian sandstone underlies the remainder of the area (Whitson, 1927). Three soil regions are represented: the Colby Silt Loams, Kennan Loam, and sandy areas (Whitson, 1927).

The general elevation of the area lies from 1250 feet above sea level in Marathon County to 1000 feet along the eastern edge of Portage County. The fall is gradual in the Marathon County waters and drops quickly in the Tomorrow-Waupaca and Little Wolf Rivers.

The last killing frost in spring at Wausau (Marathon County) is recorded for May 22 and the first in fall on Sept. 29 (USDA Yearbook, 1941). A net gain of 16 growing days is experienced as one moves south and east through the area since the city of Waupaca records killing frosts for May 10 and October 3 respectively. Average annual precipitation throughout the study area measures 32 inches (USDA Yearbook, 1941).

Tomorrow-Waupaca Rivers

The compound name Tomorrow-Waupaca has been used throughout this paper to facilitate expression. Actually it is a single body of water commonly referred to as the Tomorrow River from its upper end to its juncture with Spring Creek. Downstream from this point it is known as the Waupaca River. The Tomorrow River is subdivided into the Upper-, Middle-, and Lower-Tomorrow depending upon its location above Nelsonville, between Nelsonville and Amherst, and below Amherst respectively.

Approximately 36 miles of stream lie from its source to station 12. For the most part sandy soils predominated, although the river cuts through several belts of Kennan loams (Whitson, 1927). Up to station 12 it drains an area of 190 square miles. The Little Poncho, Eske, Bear and Spring creeks are the primary tributaries in this area. All are trout streams with the exception of Bear Creek.

According to the map of Portage County as issued by the Wisconsin State Highway Commission (February, 1957), this river arises in Twin Lakes of the Town of Sharon. The 1958 investigation, however, disclosed that there was no runoff from Twin Lakes during that summer. A narrow drybed was in evidence extending from Twin Lakes for a minimum distance of one and one-half miles. Between this point and Highway 66 (an interval of a mile) a permanent water supply arises.

At station 1 (Highway 66) the river is an average of seven feet in width with holes up to 0.8 feet in depth (Table I). No current is visible. The bottom consists of gravel overlain with a thin slurry of mud or silt. The water color is white and the bottom clearly visible. Although this is the uppermost point of access to the stream, the water temperature of 75° F. was almost eight degrees higher than that recorded some six miles downstream at station 3.

Normally we expect a stream to run its coldest water in the headwaters. This is the case with the Plover River where 54.9° F. is the lowest temperature recorded for any water for the summer. Under such circumstances the cold-water fish species lie toward the upper end of the stream and decrease numerically as the water temperatures increase downstream. However, there are many streams in the state which issue from lakes, marshes or swamps. The stream starts with tepid water and reflects this condition in supporting those fish species found in warm-water lakes and streams. As these streams move along they pick up discharge from cold springs, converting a warm-water into a cold-water stream.

On Rocky Run Creek in Columbia County, Wis., a total of 30 springs issue into a two-mile stretch of its mid-waters (Becker, 1952). Above this, Rocky Run holds bullheads, northerns and other warm-water species. In the section with the springs and for some distance below, the composition of the fish population leans toward cold-water species with a substantial population of brown trout and a token breeding population of brook trout.

The Tomorrow-Waupaca reflects to a degree what has been described above, and this will clarify in part the disruption in the longitudinal distribution of fishes, a matter which will be dealt with more thoroughly later in the paper.

The vegetative cover along the Tomorrow-Waupaca is excellent to poor. The white pine originally was the dominant tree. Today only remnant stands and sentinels remain, although most of the cutover areas have sprung up into good second growth ash and elm with oaks on the uplands. between stations 1 and 4 where the forest gives way to farms, the stream's banks have often been fenced against livestock. Many instream devices, installed by the CCC in the 1930's speed up the water. More recently the Izaac Walton League of Stevens Point has added deflecting dams and fenced additional portions of the stream against livestock.

Normally the water in the upper end (stations 1 through 4) runs white and clear but during the spring runoff the water becomes light brown. This is probably because of the peaty soils which make up a small part of the upstream drainage basin (Whitson, 1927). Below the Nelsonville millpond the water is slightly muddy in color and slightly turbid. This is likewise the situation below another im-

TABLE I

TOMORROW-WAUPACA RIVER STREAM SURVEY DATA AUGUST 9, 1958

	Station Number											
	1	2	3	4	5	6	7	8	9	10	11	12
Temp. Air °F	92.0	88.6	87.5	88.6	89.8	86.0	88.7	85.1	80.5	82.4	78.4	78.6
Water °F	75.0	78.3	67.4	69.8	78.3	79.9	79.8	71.3	70.4	70.0	68.8	71.8
Time of Day	1630	1600	1710	.....	1435	.....	.....	1230	.....	1105	.....	.....
Ave. Width (ft.)	7.5	17.9	27.8	.....	39.2	65.1	41.3	81.7	42.9	49.8	88.0	41.5
Ave. Depth (ft.)	0.4	0.5	0.8	.....	1.2	0.7	0.8	0.7	1.0	0.8	.....	1.3
Max. Depth Recorded	0.8	1.1	1.8	.....	2.5	1.3	1.8	1.7	1.9	1.3	1.1	2.5
Velocity ft./sec	.....	0.2	0.7	.....	1.5	1.2	2.6	1.7	2.2	3.3	2.4	2.6
Volume of Flow cu. ft./sec	.....	0.14	12.8	.....	54.7	43.4	67.9	78.9	74.7	106.3	.....	110.6
Bottom % — Sand	.....	.....	.....	.....	15	70	5	5	30	.....	.....	.....
Bottom % — Gravel, clean	.....	.....	60	20	80	.....	.....	.....	.....	.....	20	.....
Bottom % — Gravel, silt	100	.....	.....	.....	.....	.....	}	.....	70	100	.....	.....
Bottom % — Rubble	.....	10	.....	.....	.....	30	95	95	.....	.....	.....	95
Bottom % — Boulders	.....	.....	.....	.....	5	.....	}	.....	.....	.....	80	.....
Bottom % — Mud and silt	.....	90	40	80	.....	.....	.....	.....	.....	.....	.....	5
Color of Water*	W	W	W	W	W	W	W	LB	LB	LB	LB	LB
Turbidity†	C	C	C	C	ST	ST	C	ST	ST	ST	ST	ST

*W—white; LB—light brown.
†C—clear; ST—slightly turbid.

poundment at Amherst, two and one-half miles downstream. Several times daily, water is released from the millponds and the river then runs high and very turbid. The effect of this variable silt load on the fish species needs evaluation.

The Tomorrow-Waupaca possesses a firm bottom of gravel, rubble and boulders and exceeds all other streams in velocity with 3.3 feet per second recorded at station 10. The Upper Tomorrow is today classified by the Wisconsin Conservation Department as excellent brook trout water. The Middle Tomorrow is considered fine brown trout water.

The fish survey was made at 12 stations from August 2nd through the 8th. Approximately 3700 fish of forty-one species were handled during the survey. Three additional species have since been added on the basis of a collection made at station 7 on April 25, 1959.

Little Wolf River

From July 21st through the 28th over 4700 fish of thirty-nine species were recorded from 14 stations. Between station 14 and its source, it is estimated that the river is 46 miles long. Its drainage basin down to station 14 is 425 square miles. Physical data are recorded on Table II.

The Little Wolf River arises from springs and spring ponds in the southeastern corner of Marathon County, and courses in a general southeasterly direction into Waupaca County. The first half of its course drains Kennan loam soil, except where the river cuts over the northeast corner of Portage County. Here it passes through a brief sandy area. As the river takes a strong southerly bearing in middle Waupaca County, it enters the Miami silt loams and drains these down to station 14, except for a two-mile stretch of red clay just north of the city of Manawa (Whitson, 1927).

Impoundments were noted at Galloway (below station 2), above Riemer's Ripps (above station 7), Big Falls (below station 8), Little Falls (at station 12), and Manawa (between stations 12 and 13). Several smaller stone dams erected by landowners were seen in the upper stretches between stations 1 and 7. The following creeks: Holt, Bradley, Comet, Flume, Spaulding, Whitcomb, Shaw and Blake, are the principal tributaries draining the watershed. With the exception of Shaw Creek, the aforementioned are trout streams, at least in part.

Upstream from Big Falls the banks are strongly wooded. Hardwoods are most common although there is a strong addition of white cedar between stations 6 and 7. Below Symco the river is more open. Despite the fact that much farming is carried on here, there was very little sign of erosive silts except for the area worked at

TABLE II

Little Wolf River Stream Survey Data August 15, 1958

	Station Number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Temp. Air °F.	69.5	68.4	72.5	74.6	75.5	71.7	.....	.....	73.8	72.3	71.7	.....	73.3	71.8
Water °F.	64.2	66.0	73.4	68.8	74.5	74.2	73.8	75.8	76.6	75.2	74.7	74.8	75.8	74.9
Time of Day	.....	.....	.....	1600	.....	.....	.....	.....	1345	.....	.....	.....	1130	1050
Ave. Width (ft.)	8.5	16.3	16.5	24.8	47.0	50.0	64.5	.....	103.0	.....	68.5	.....	120.0	92.0
Ave. Depth (ft.)	0.2	0.7	0.2	0.5	0.6	1.1	1.1	.....	1.0	0.8	1.1	.....	2.2	1.9
Max Depth Recorded	1.2	1.3	0.5	1.0	1.4	2.1	2.2	.....	1.7	1.7	2.2	.....	3.4	2.7
Velocity ft./sec.	.....	0.6	1.9	1.1	1.1	0.7	1.1	.....	1.0	1.7	1.0	.....	0.5	0.7
Volume of Flow cu. ft./sec.	0.2	0.5	4.9	11.3	24.5	28.9	64.5	.....	84.2	.....	60.4	.....	95.3	101.2
Bottom % — Mud and/or silt	100	50	5	5	.....	10	5	.....	.....	.....	5	60	.....	.....
Bottom % — Gravel, silt	.....	.....	95	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bottom % — Gravel, clean	.....	.....	.....	95	85	10	95		90	.....	.....	40	.....	
Bottom % — Rubble	.....	.....	.....		15	.....	.....	100	10	.....	.....	.....	.....	95
Bottom % — Boulders	.....	.....	.....	.....		.....	.....		.....	.....	.....	.....	.....	
Bottom % — Sand, hardpan	.....	50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bottom % — Sand	.....	.....	.....	.....	.....	80	.....	.....	.....	.....	95	.....	.....	5
Color of Water*	W	W	W	W	W	W	W	W	W	W	W	LB	W	LB
Turbidity†	ST	C	C	C	C	C	C	C	C	C	C	ST	C	C

*W—white; LB—light bornw.
†C—clear; ST—slightly turbid.

station 12. Just above the head of an impoundment was a cattle crossing. Below this the waters were muddy, and the collection was made entirely with a seine.

Plover River

A total of 35 species of fish was recorded from the Plover's 14 stations. Over 4100 fish were handled. Stations 2 through 13 were sampled June 23rd to June 27th. Station 14 was sampled July 29th; station 1, August 11th. The Plover's drainage area is an estimated 162 square miles. Total length of the stream from its source in Langlade County to its mouth in Portage County is estimated at 49 miles.

Arising in large springs the Plover begins as a first-class trout stream. A temperature of 54.9° F. at station 1 was the lowest recorded anywhere for the summer (Table III). This condition is soon reversed. At station 4 the temperature has reached the upper tolerance limit for species like the rainbow and the brown trout. Few tributaries were seen. The overflow from Pike, Wadley, and Big Bass lakes joins the river in Marathon County.

The Plover arises in a wooded area, but for most of its course the banks have been denuded of vegetative cover and farming enterprises are evident. Despite these disturbances the water runs clear except during periods of excessive precipitation. The upper half of the stream is in an area of Kennan loam soils, the lower half drains sandy soils (Whitson, 1927).

The stream bottom is largely gravel. Rubble and boulders are confined to the upper half of the stream. Generally the river is wide and shallow. Its volume of flow is quite erratic because of regulation of water by impoundments. Large dams were noted at Hatley, Jordan, and McDill, along with another structure at a point two miles above Jordan. In addition several smaller structures were seen on private farm lands.

Little Eau Pleine River

From July 6th through the 18th over 3600 individuals of 33 species were examined from the Little Eau Pleine. Nine stations were plotted in the upper two-thirds of the river. Because the water was dark and turbid, most of the samples were made with the seine. Only at stations 5 and 6 was the electrofishing equipment used exclusively.

Flowing through the southern part of Marathon County from west to east, the Little Eau Pleine traverses an extremely flat terrain with very limited gradient. It lies in the southern peneplain of the Northern Highland (Martin, 1916). The most perceptible drop was noted at stations 5 and 6, which was immediately re-

TABLE III

Plover River Stream Survey Data August 11, 1958

	Station Number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Temp. Air °F.	75.0	76.2	.....	76.2	.....	81.4	.....	80.8	.....	86.6	.....	.....	.....	.....
Water °F.	54.9	65.5	69.8	75.1	74.8	79.3	78.0	78.4	79.9	78.8	80.9	80.2	81.0	78.5
Time of Day	1130	1235	1300	.....	.....	.....	.....	.....	.....	.....	.....	1630	.....	.....
Ave. Width (ft.)	9.4	40.5	.....	83.3	.....	107.0	.....	64.4	.....	61.0	.....	49.2	.....	132.0
Ave. Depth (ft.)	0.5	1.1	.....	0.6	.....	1.0	.....	1.0	.....	1.3	.....	1.2	.....	1.2
Max. Depth Recorded	1.0	1.8	.....	1.0	.....	1.6	.....	2.2	.....	2.3	.....	3.1	.....	2.5
Velocity ft./sec.	0.38	0.53	.....	1.1	.....	0.5	.....	1.3	.....	1.8	.....	0.8	.....	1.0
Volume of Flow cu. ft./sec.	1.4	19.2	.....	44.8	.....	42.6	.....	63.6	.....	115.0	.....	38.3	.....	131.0
Bottom % Sand	.....	.....	.....	95	.....	.....	.....	40	.....	50	.....	.....	.....	20
Bottom % Sand and Gravel	.....	90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bottom % Mud and/or Silt	.....	.....	X	.....	60	30	.....	20	10	50	.....	.....	.....	.....
Bottom % Gravel	100	.....	X	.....	40	70	95	40	90	.....	.....	100	.....	50
Bottom % Rubble	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bottom % Boulders	.....	10	X	5	.....	.....	5	.....	.....	.....	.....	.....	.....	.....
Color of Water*	W	W	LB	LB	LB	LB	LB	LB	LB	LB	.....	W	.....	W
Turbidity†	C	C	ST	ST	C	C	ST	ST	C	C	.....	C	.....	C

*W—white; LB—light brown.
†C—clear; ST—slightly turbid.

flected in the clearing water and in the occurrence of species like the stonecat, rainbow darter, smallmouth bass, striped fantail and rock bass. The remainder of the stream was a series of turbid currentless pools, connected by shallow necks filled with vegetation and rocks.

There were many tributaries coming into the river from the north and south at right angles to the Eau Pleine bed. For the most part these tributaries were dry. Occasionally a pool of water remained but many of these disappeared by the end of August. From its source to station 8 the soils drained were of the Colby silt loam type. From that point downstream to station 9 the basic soil is peat.

The Little Eau Pleine is noted for its dense populations of many species of minnows. By its very nature the river is a series of quiet minnow ponds. These are deep and have been scooped into the plain through which the river flows. Even at station 1 we encountered holes which were too deep for wading and which were estimated to be over four feet in depth. Although this statement appears contrary to the survey data (Table IV) in which 2.4 feet was the maximum depth recorded, it must be emphasized here that the recorded figure is the maximum depth which appeared in a random sample for computing the average depth.

The portions of stream sampled passed through extensively farmed land. Grazing along the banks was common especially along the upper sections of stream. Footing in the stream proved treacherous because of the heavy clay gumbo which gave way to mud flats along the bank.

Sedimentary deposits of the Paleozoic era were absent at stations 5 and 6. At these stations igneous boulders and bedrock of pre-Cambrian origin had been laid bare by stream action. According to Martin (1916), a pre-Cambrian mountain range formerly covered the entire Lake Superior Highland region. The Little Eau Pleine lies entirely in the driftless area of the Wisconsin glaciation although its headwaters occur within the region of the older drift.

Little Eau Claire River

Twenty-four species representing nine families were identified from a total of 867 individuals collected at five stations. The Little Eau Claire is only 17 miles in length and drains a watershed of 63 square miles.

The river bed is located on the edge of the glacial moraine. At station 5 the water has cut a gully approximately 20 feet deep. The bottom of the river is underlain with sharp rocks of the igneous type. This apparently is part of the pre-Cambrian peneplain described for the Little Eau Pleine River. Both rivers join the Wisconsin at the Marathon-Portage county line. At station 1 granite

TABLE IV

LITTLE EAU PLEINE RIVER STREAM SURVEY DATA AUGUST 16, 1958

	Station Number								
	1	2	3	4	5	6	7	8	9
Temp. Air °F	70.4	.....	72.4	72.4	70.2	69.3	67.8	66.8	64.5
Water °F	71.1	77.0	70.3	74.2	68.9	72.1	70.4	66.9	68.3
Time of Day	.....	.....	.....	.....	.....	.....	.....	1125	1100
Ave. Width (ft.)	16.7	16.0	32.3	43.0	52.0	34.8	46.5	62.3	68.0
Ave. Depth (ft.)	0.8	0.4	1.6	1.6	1.1	1.0	0.8	2.0	1.9
Max. Depth Recorded	2.4	0.7	2.6	3.4	2.2	2.2	1.5	3.0	2.7
Velocity ft./sec	.....	0.5	.....	.....	.....	.....	0.3	0.1	0.2
Volume of Flow cu. ft./sec	Est 0.1	2.4	.....	.....	.....	.....	8.5	11.9	20.6
Bottom % — Mud and clay	50	.....	100	100	.....	.....	X	100	90
Mud and/or silt	.....	.....	.....	.....	10	.....	.....	.....	10
Gravel, silt	.....	100	.....	.....	.....	.....	.....	.....	.....
Gravel, clean	50		.....	.....	.....	.....	X	.....	.....
Rubble	.....		.....	.....	90	100	X	.....	.....
Boulders	.....	.....	.....	.....			.....	.....	.....
Bedrock	.....	.....	.....	.....	.....		.....	.....	.....
Color of Water*	LB	LB	DB	DB	W	W	DB	DB	DB
Turbidity†	T	ST	ST	ST	C	C	ST	ST	T

*W—white; LB—light brown; DB—dark brown.
†C—Clear; ST—slightly turbid; T—turbid.

constituted a large part of the stream bottom and contributed to bank outcroppings.

The stations were sampled on July 9th and 10th. At that time little difficulty was experienced in using the shocking boat, although it was necessary to drag it every now and then over grassed and gravelled areas which were overlain with a run of water two to three inches in depth. Less than a month later, on August 7th, the Little Eau Claire had become an intermittent stream (Table V). At stations 2, 3, and 4 the stream was a series of dead pools separated by stretches of dry gravel, sand, and grassy swales. At station 4 a single instance of water trickle between two pools was noted. This implies that there was possibly a limited amount of water movement in the form of seepage.

TABLE V

LITTLE EAU CLAIRE RIVER STREAM SURVEY DATA AUGUST 7, 1958

	Station Number				
	1	2	3	4	5
Temp. Air °F	70.4	75.0	73.7	72.7	70.0
Water °F	65.5	76.4	72.0	75.5	68.0
Ave. Width (ft.)	12.7	10.5	9.2	14.9	26.6
Ave. Depth (ft.)	0.7	0.4	0.4	0.6	0.7
Max. Depth Recorded (ft.)	1.4	1.0	0.9	1.4	1.3
Volume of Flow gals./sec. estimate	0.3	none	none	none	2.0
Bottom % Silt					10
Bottom % Sand	20			100	
Bottom % Gravel		90	100		
Bottom % Rubble		10			90
Bottom % Boulders	80				
Color of Water*	LB	LB	LB	LB	LB
Turbidity†	T	T	T	ST	ST

*LB—light brown.
†T—turbid; ST—slightly turbid.

Intermittency places undue hardship on many fish species. Stream havens (Paloumpis, 1958) enable the survival of fish species which normally would disappear in such intermittent waters. These havens are normally in the form of small tributary streams, isolated pools in the channel, flood plain ponds and larger permanent streams which the intermittent streams join.

The only stream havens noted on this river were the isolated channel pools. Many of these no longer served as fish habitat due to their excessive shallowness. At station 2 in one pool less than two inches deep a dead Johnny darter was recovered. There was no life in this pool that we could see. A dry bed of 80 feet was measured between two pools at the same station and a depth of 23.2 inches was recorded for one pool. Into this a square yard throw net was lowered and immediately retrieved. The common shiner, brook stickleback, white sucker and creek chub were taken in numbers along with many small fry of these fish species.

Concentrations of fish in this one pool indicates that under such conditions a severe food problem may occur, especially for the young of the year. Also, due to highly restricted living space, absence of bank cover and presence of carnivorous minnows, the entrapped fry would survive poorly. Another pool at the same station yielded specimens of the red-belly dace, pearl dace and black bullhead in addition to the aforementioned species.

Another real problem is pointed up when comparing the air and water temperature data. Extremely high air and water temperatures during the day fluctuating with correspondingly low temperatures at night may feasibly press the acclimation ability of certain fish species. It is possible that the accompanying physiological strain may result in decimation. This may account for the fact that this river produced the lowest number of species.

The Little Eau Claire had nine or 27% fewer species than the Little Eau Pleine and Plover rivers. Twenty-four species were recorded in all. Despite the fact that equal time and effort was expended in making collections, the Little Eau Claire produced only 173 specimens per station, the lowest of the five major streams sampled.

Its banks were overgrown with hardwoods at stations 1 and 5. All other stations were open and the banks heavily grazed. Kennan loams overlie the bulk of the drainage area (Whitson, 1927).

Mill Creek

Seventeen species representing six families were collected at two stations (Map 1). These collections were made at the lower end of Mill Creek on July 30, 1958. The water was very turbid at the time and its volume of flow was scarcely sufficient between the long, deep pools to float the shocking equipment.

This stream flows through the heart of the dairy farm industry in northern Wood County. It is an open slow-moving stream consisting mostly of deep pools scoured out of sedimentary deposits. Mill Creek belongs to the same geological formation described for

the Little Eau Pleine River and flows parallel with it in the same general direction. Colby silt loams are the general soil type (Whitson, 1927).

Haymeadow Creek

Thirteen species representing eight families were collected at three stations on July 9, 1958 (Map 1). Natives frequently use the name "Coffee Creek", an apt description of its dark brown and highly turbid water. Electrofishing proved virtually useless since it was impossible to see more than a few inches beneath the surface and for the most part the stream ran deep. Even at station 1 there were holes that could not be waded. The bottom was littered with brush and other snags, making seining very difficult. Consequently it was felt that this stream got very poor survey coverage.

Peat marsh and low sandy areas constitute the major land types in its abbreviated drainage area. The flow of the stream was considerable even when revisited in late August.

The paucity of the minnow species probably reflects the size of the northern pike population. Our samples turned up several young of this predator species at stations 1 and 3. The only lawyer collected during the summer was taken at station 3.

Number of Species Recorded and Factors in Distribution

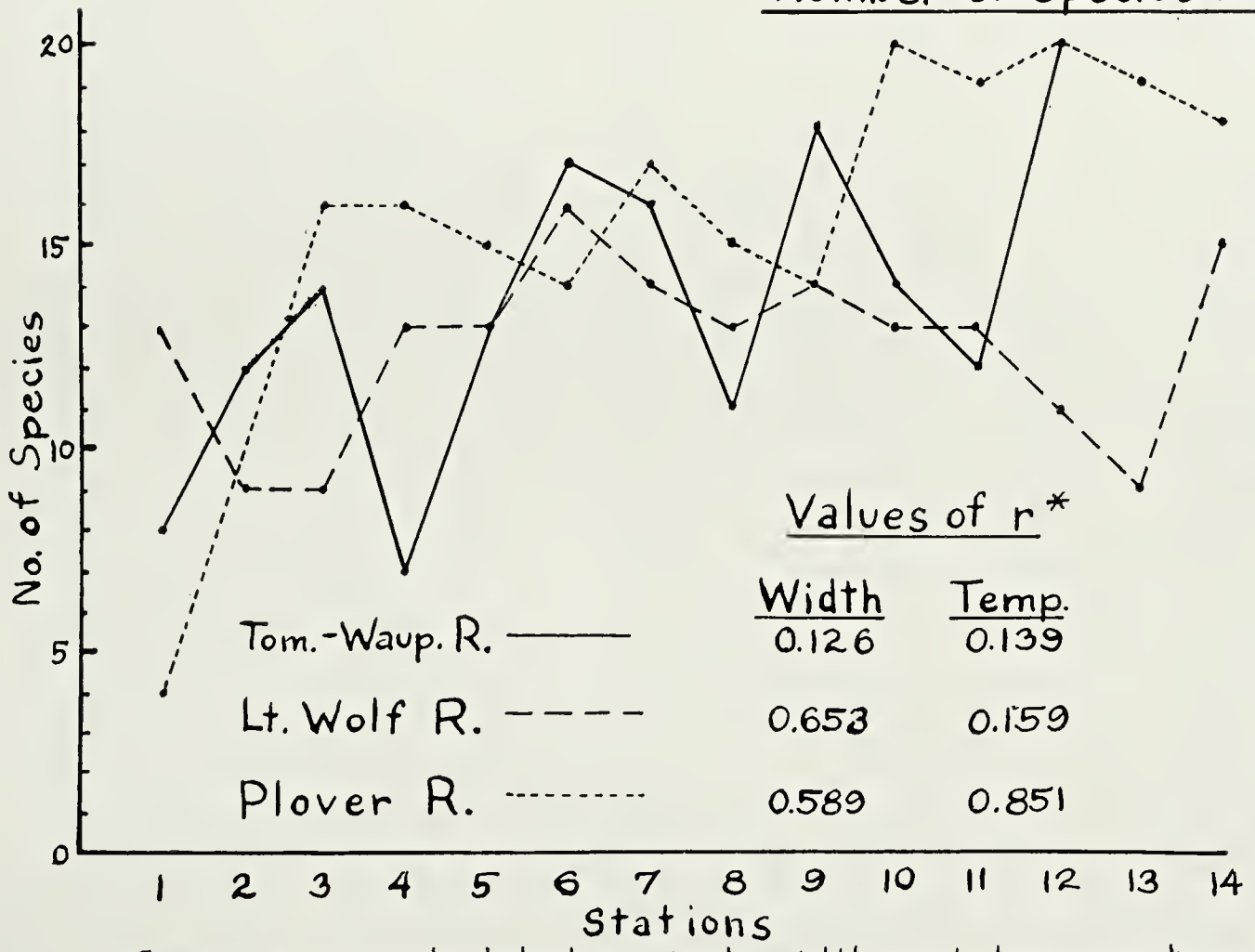
The Tomorrow-Waupaca and Little Wolf Rivers, both in the Great Lakes watershed, produced the greatest number of species of fish, 41 and 39 respectively. Thirty-five (35) were taken in the Plover, 33 in the Little Eau Pleine, and 24 in the Little Eau Claire. Figure 1 shows the number of species recorded per station. It is evident that the variety of species is fairly high per station in both the Plover and the Little Eau Pleine despite the fact that the overall species number is not as great as in the Tomorrow-Waupaca and Little Wolf rivers.

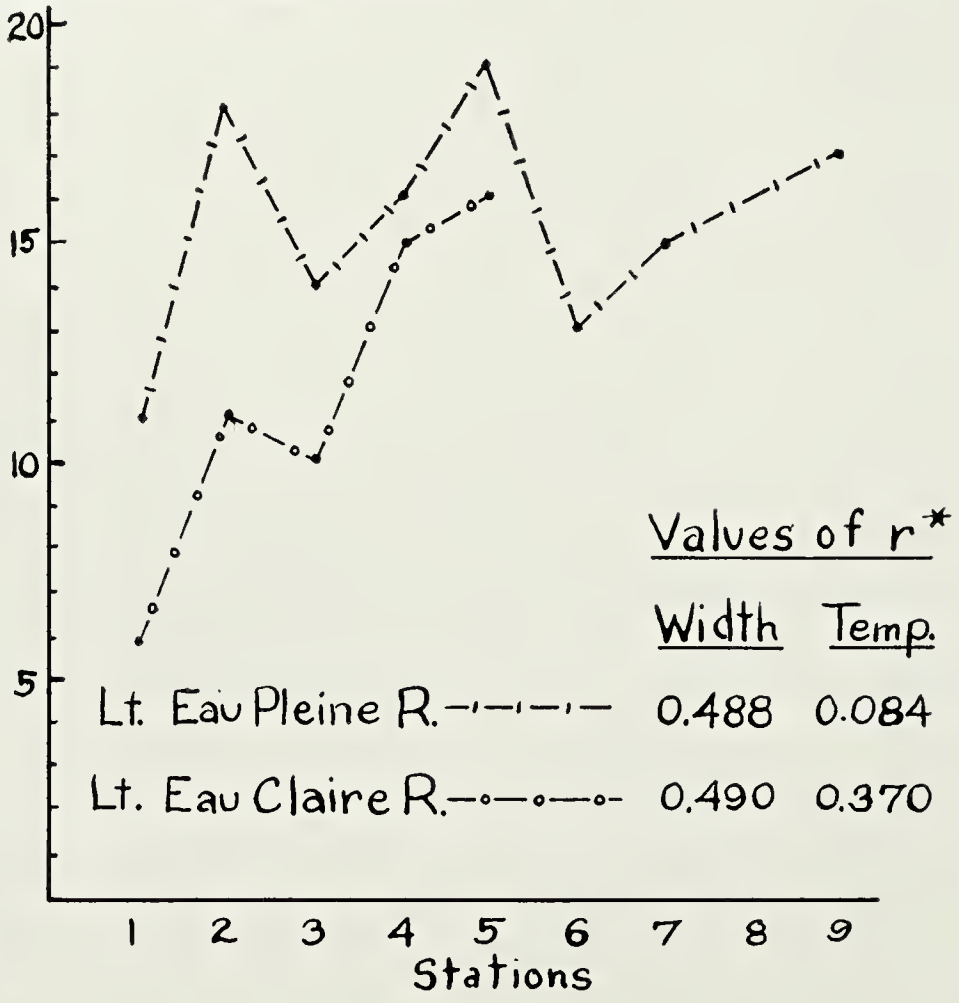
It is likewise evident that species number per station increases as one moves from headwaters downstream. Correlation coefficients were calculated between species number and stream width (Figure 1). The relationship between stream size and species number has been reported by Starrett (1950) and Thompson and Hunt (1930).

An attempt was made to establish correlations between species number and water temperature (Figure 1). With the exception of the Plover these coefficients were low. It appears that temperature is not as reliable a factor in predicting the number of species which will be encountered as is stream width.

Figure 1

Number of Species Recorded Per Station





* Species no. calculated against width and temperature

However it should be mentioned that species number and distribution are subject to errors of omission. In rapidly covering three stations per day, ecological niches harboring remnant populations may have been overlooked. Three types of data point out this error:

(1) Many of the species recorded at a particular station were recognized on the recovery of a single individual, showing the tenuous margin under which our sampling method operated. At station 12 on the Plover River five of the twenty species (25%) were recorded on the recovery of a single individual of each species; another, on two individuals. Twelve species out of the 20 (60%) were represented by seven or less individual fish.

(2) Sampling at three selected stations prior to or subsequent to the regular survey run raised the number of species by 25%. In early August during the regular survey run at station 7 of the Tomorrow-Waupaca River, a total of 13 species was recorded. Subsequent sampling later that month added the central stoneroller, the central bigmouth shiner and the largemouth bass, the latter, a single individual and the only record for that species taken on the entire stream.

At station 3 of the Tomorrow-Waupaca, a preliminary survey was made with minnow traps in May and June. At that time the blacknose dace, the northern redbelly dace and the brook stickleback were taken among others. The regular August survey run failed to turn up these three species. On the Plover River at station 13 four of the 19 species recorded were the product of repeat sampling. The above three examples represented increases through additional sampling by 23%, 27% and 27% respectively.

(3) The importance of repeat sampling is seen most clearly when the 1958 survey is compared with the work of Greene (1935). Table VI shows a substantial increase in species number for each stream, an increase apparently a result of additional sampling, assuming that the composition of the fish species remained the same since the late 1920's when Greene did his work.

Greene made a total of nine collections for the entire area—the 1958 survey a total of 59. Greene recorded 44 species; the 1958 study produced 53. Two species, the northern weed shiner (*Notropis roseus richardsoni* Hubbs and Greene) and pugnose shiner (*Notropis anogenus* Forbes), were taken by Greene on Blake Creek, a tributary to the Little Wolf River flowing eastward and joining the Little Wolf midway between stations 11 and 12. Although the 1958 survey did not sample Blake Creek, these additional species were added as definite records for the area. With subsequent sampling it is hoped that these forms will turn up not only on Blake Creek but on other waters.

The possibility exists that both the weed shiner and pugnose shiner could have been overlooked in our sampling. Both species

TABLE VI

COMPARISON OF FISH SPECIES NUMBERS, 1928* AND 1958

	Tomorrow–Waupaca River		Little Wolf River		Plover River		Lt. Eau Pleine River	
Year of Study	1928	1958	1928†	1958	1928	1958	1928	1958
No. of Collections	2	12	4	14	3	14	1	9
No. of Species in Common	17	17	29	29	18	18	11	11
Species by One Worker Only	3	24	6	10	7	15	.....	22
Total Species Recorded	20	41	35	39	25	33	11	33
Species Reported by Greene Only [1]	Greater Redhorse Golden Redhorse Blackchin Shiner		Pugnose Shiner No. Redfin Shiner No. Weed Shiner Blackchin Shiner Slenderhead Darter Lawyer		No. Redfin Shiner Golden Shiner So. Redbelly Dace Channel Catfish Yellow Perch Iowa Darter Lawyer		None	

*Prepared from distribution maps in Greene (1935).
†Blake Creek, a tributary, is included.
[1]The underlined species were not recorded in 1958.

were taken infrequently by Greene, the Blake Creek records being the only ones taken from that part of Central Wisconsin. Starrett (1950) mentions the delicate balance of conditions in Iowa permitting the existence of a species in relatively low numbers until a slight change in environment brings about a dynamic surge in population.

The blackchin shiner (*Notropis heterodon* Cope) and northern redfin shiner (*Notropis umbratilis cyanocephalus* Copeland) were reported by Greene from the Tomorrow-Waupaca and Plover rivers respectively, and both from Blake Creek. The 1958 survey failed to turn up these species probably due to paucity in numbers. It has already been pointed out that several of the 53 species are listed on the recovery of one or two individuals.

Illustrative of this are the lawyer (one fish) and the least darter (two individuals). Repeated attempts were made to recover more least darters but no additional specimens appeared. It is highly improbable that our operations took the last two individuals of a species. The narrowness of the shocking and seining areas, the limitations of equipment to recover fish, the inaccessibility of deep holes, physical barriers like dams, logs, boulders and the like—all operated in favor of the fish. Also fish movements into and out of an area must be considered.

The longitudinal distribution of an individual species, however, through analysis of empirical data appears to be a function of both stream size and water temperature. Large stream size produced species like the northern logperch, silver redhorse and the spotfin shiner. Small waters yielded the Iowa darter, northern blacknose shiner, brook trout and the northern redbelly dace.

This does not necessarily mean that these fish are entirely confined to headwaters. Several of the above "small-water species" were taken at downstream stations (e.g., the Iowa darter, taken at stations 7 and 9 on the Little Eau Pleine River), yet they were encountered most frequently at the first three or four stations in the greatest numbers.

In the case of the brook trout we find a correlation with small stream size not because of any inherent preference for such but because the water temperature requirement is met. Headwaters are generally springfed and so they are the only sections of the stream which keep within the restricted tolerance level of that species. According to Wisconsin findings (Brasch et al., 1958), the brook trout will succumb if held at about 77.5° F. for more than a few hours.

Stream gradient appeared to play an important part in the distribution of species like the smallmouth bass, rock bass, stonecat, longnose dace, rosyface shiner, hog sucker and stoneroller. The

TABLE VII

Composition of the Family Cyprinidae

	Tomorrow–Waupaca		Little Wolf		Plover		Little Eau Pleine		Little Eau Claire		Totals	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cyprinus carpio	9	0.4	.....	.....	.....	.....	.....	.....	.....	.....	9	0.1
Campostoma anom. pull.	61	2.9	.....	.....	179	9.6	34	2.2	.....	.....	274	3.2
Rhinichthys cataractae	628	29.9	205	7.0	19	1.0	.....	.....	.....	.....	852	9.9
Rhinichthys atrat. mel.	412	19.6	650	22.0	217	11.6	7	0.5	1	0.7	1287	15.0
Hybopsis biguttatus	55	2.4	292	9.9	128	6.9	96	6.3	.....	.....	571	6.6
Semotilus a. atromac.	283	13.5	391	13.3	146	7.8	86	5.6	32	20.7	938	10.9
Semotilus margarita n.	86	4.1	102	3.5	6	0.3	*	.....	12	7.8	206	2.4
Chrosomos eos	5	0.2	27	0.9	4	0.2	89	5.8	38	24.6	163	1.9
Notemigonus cry. aurat.	1	0.1	2	0.1	.....	.....	10	0.7	1	0.7	14	0.2
Pimephales p. promelas	5	0.2	3	0.1	.....	.....	15	1.0	1	0.7	24	0.3
Pimephales notatus	29	1.4	303	10.3	502	26.8	217	14.2	14	9.1	1065	12.4
Notropis corn. frontal.	422	20.1	871	29.5	578	31.4	470	30.7	44	28.6	2394	27.8
Notropis rubellus	73	3.5	24	0.8	1	0.1	6	0.4	.....	.....	104	1.2
Hybognathus hankinsoni	.....	.....	2	0.1	.....	.....	36	2.4	.....	.....	38	0.4
Notropis spilopterus	2	0.1	26	0.9	.....	.....	.....	.....	.....	.....	28	0.3
Notropis h. heterolepis	2	0.1	39	1.3	59	3.2	405	26.4	10	6.5	515	6.0
Notropis delic. stramin.	24	1.1	1	0.03	.....	.....	.....	.....	.....	.....	25	0.3
Notropis v. volucellus	1	0.1	6	0.2	.....	.....	.....	.....	.....	.....	7	0.1
Notropis d. dorsalis	1	0.1	.....	.....	23	1.2	60	3.9	1	0.7	85	1.0
Totals	2099	100	2944	100	1871	100	1531	100	154	100	8599	100
Total no. of Species	18		16		12		14		10		19	

*Presence recorded through subsequent sampling.

TABLE VIII

Composition of the Family Percidae*

	Tomorrow–Waupaca		Little Wolf		Plover		Little Eau Pleine		Little Eau Claire		Totals	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Perca flavescens	6	1.8	.....	.....	.....	.....	59	13.4	23	18.3	88	3.9
Hadropterus maculatus	4	1.2	81	17.2	50	5.8	131	29.8	21	16.7	287	12.9
Percina cap. semifasc.	14	4.2	82	17.2	1	0.1	.....	.....	3	2.4	100	4.5
Etheostoma n. nigrum	149	44.8	144	30.7	328	38.2	193	43.9	49	38.9	863	38.7
Etheostoma microperca	.....	.....	.....	.....	2	0.2	.....	.....	.....	.....	2	0.1
Etheostoma z. zonale	97	29.1	107	22.8	50	5.8	.....	.....	.....	.....	254	11.4
Etheostoma exile	.....	.....	49	10.4	.....	.....	3	0.7	22	17.4	74	3.3
Etheostoma caeruleum	53	15.9	.....	.....	299	34.8	28	6.4	.....	.....	380	17.0
Etheostoma flab. lin.	10	3.0	7	1.5	129	15.1	26	5.9	8	6.3	180	8.1
Totals	333	100	470	100	859	100	440	100	126	100	2228	100
Total no. of Species	7		6		7		6		6		9	

*Single specimen of *Stizostedion vitreum* taken on Mill Creek.

darters as a group were found generally in fast, shallow water with a rocky or gravelly substrate. A common associate species with the longnose dace was the hornyhead chub although a high gradient appeared less important in the distribution of the latter species. Burton and Odum (1945) and Trautman (1942) discuss at length the significance of gradient of flow in fish distribution.

Fish Species and Their Distribution

Two groups of fishes particularly well represented in the survey were the cyprinids and the perch family. Sixty-four percent of the summer's catch came from these families. Table VII summarizes percentagewise the composition of the minnow family. The 8599 individuals collected composed 51% of all the fish taken during the survey. According to Greene (1935) and Hubbs and Lagler (1958), 37 species and two subspecies of minnows are found in Wisconsin. The survey recorded a total of 19 species from 10 genera (Table VII).

Thirteen percent of all fish collected in the survey were members of the perch family (Table VIII). They constituted ten species from five genera. Fourteen species and two subspecies have been listed from the state.

Table IX lists the ten most common fishes taken on each of the five major streams. The average number of species per stream is 34; consequently the ten most common represent 29% of the average number per stream. It is interesting to note, however, that those selected species contributed individuals amounting to 86% of the total catch. This fact supports the contention made earlier that many species gained listing on the basis of few recoveries. Seventy-one percent or an average of 24 species per river made up only 14% of the total catch.

Under each species the name of the river is abbreviated and is immediately followed by the number(s) of the station(s) where found:

T—Tomorrow-Waupaca River
LW—Little Wolf River
P—Plover River
LEP—Little Eau Pleine River
LEC—Little Eau Claire River
H—Haymeadow Creek
M—Mill Creek

Common and scientific names follow the revised Hubbs and Lagler (1958).

1. **American Brook Lamprey**—*Entosphenus l. lamottenii* (LeSueur) P 2, 12, 13; LEC 5; H 2. Identification of this species and

TABLE IX

Ten Most Common Species and Percentage Composition*

Tomorrow–Waupaca River		Little Wolf River		Plover River		Little Eau Pleine River		Little Eau Claire River	
Species	%	Species	%	Species	%	Species	%	Species	%
Longnose dace	17.1	No. common shiner	18.6	Com. white sucker	24.4	Brook stickle-back	23.3	West. mud-minnow	44.1
Com. white sucker	16.7	West. blacknose dace	13.9	No. common shiner	14.2	No. common shiner	12.9	Com. white sucker	17.0
No. common shiner	11.4	Com. white sucker	11.7	Bluntnose minnow	12.3	Blacknose shiner	11.1	Cent. Johnny darter	5.7
West. blacknose dace	11.2	No. creek chub	8.4	Cent. Johnny darter	8.1	West. mud-minnow	11.1	No. common shiner	5.1
No. mottled sculpin	11.2	Bluntnose minnow	6.5	Rainbow darter	7.4	Com. white sucker	6.8	Brook stickle-back	4.6
No. creek chub	7.7	Hornyhead chub	6.3	West. blacknose dace	5.6	Bluntnose minnow	6.0	No. redbelly dace	4.4
Cent. Johnny darter	4.1	Longnose dace	4.4	Cent. stoneroller	4.4	Cent. Johnny darter	5.3	No. creek chub	3.7
Striped fantail	2.6	No. rock bass	3.8	No. creek chub	3.6	Blackside darter	3.6	Yellow perch	2.7
Hog sucker	2.6	No. mottled sculpin	3.7	Striped fantail	3.2	Hornyhead chub	2.6	Iowa darter	2.5
No. pearl dace	2.3	Brook trout	3.6	Hornyhead chub	3.2	No. redbelly dace	2.4	Blackside darter	2.4
Total %	86.9		80.9		86.4		85.1		92.2

*The American brook lamprey and the northern brook lamprey are excluded from this listing since no quantitative data were taken on them.

the next is based on the adult term only. Since the survey was made after the normal breeding season for lampreys, few adults were recovered. Our records extend the range somewhat northward than that listed by Greene (1935).

Ammocoetes (species undetermined) were taken on the Plover River 2 through 13; LW 9, 10, 11; T 2 through 12.

2. **Northern Brook Lamprey**—*Ichthyomyzon fossor* (Reighard and Cummins) T 4, 7. These are the first records of this species in Wisconsin's Great Lakes watershed. Greene (1935) states that this species is definitely known from the Mississippi drainage in Wisconsin. Both species of brook lampreys were not treated numerically since they were hard to recover. In slow sandy areas, where they were particularly abundant, an attempt to recover all the lamprey seen would have resulted in an incomplete treatment of the other fish species.

3. **Brook Trout**—*Salvelinus fontinalis* (Mitchell) T 1, 2, 3, 4; LW 1, 2, 3, 4, 5; P 1, 2, 3, 5, 7. Forty-five brook trout were taken on the Tomorrow-Waupaca at station 3. These constituted 16% of all fish counted for that station. On the Little Wolf River 45% of the fish taken at station 2 were of this species. The best ratio occurred at station 1 of the Plover River where 84 *Salvelinus* comprised 59% of the catch. The majority of these trout were approximately five inches in length.

This species of trout was by far the most successful and occurred in colder headwaters over gravel bottoms. From Greene's (1935) distribution map it is apparent that this species was taken near the mouth of the Plover River in the vicinity of station 14. If this should be a record of an unplanted trout, it implies a profound increase in water temperatures in the lower Plover since the late 1920's.

4. **Brown Trout**—*Salmo trutta fario* (Linn.) T 2, 3, 4, 5, 6, 7, 8, 11: LW 4, 6, 7; P 1, 2, 3, 7. On the Tomorrow-Waupaca one or two individuals were recorded for each of seven stations; at station 3, fifteen browns were shocked. The Little Wolf produced ten browns in all; the Plover, nine. Larger trout are masters at evading the electrodes. Often they travel so swiftly that their momentum carries them through the electrical field, making recovery difficult. In order to take the smaller fishes the electrodes were held five to seven feet apart. The trout avoided us most frequently by swinging around to the outside of the effective shocking area. This was especially the case where the river was wide. It is therefore estimated that only a minor percentage of trout were taken at the lower stations where present. The largest brown was taken on the Little Wolf at station 6 and measured 17″. Greene (1935) states; "This species is now of common distribution in the trout waters of the

state." His distribution map includes no records from our study area.

5. **Coast Rainbow Trout**—*Salmo gairdnerii irideus* (Gibbons) T 7, 9; LW 4, 6. A total of 12 rainbow trout (nine from the Little Wolf) were recorded for the summer. Tolerant of higher water temperatures than the other trout, the rainbow generally demands fairly deep rushing water. However, the two largest rainbows, both 14 inches long, were taken in deep smooth-water holes at station 6 on the Little Wolf. No individuals are recorded by Greene (1935) from the study area.

6. **Silver Redhorse**—*Moxostoma anisurum* (Rafinesque) LW 14. The five individuals taken measured about five inches each in length. Greene (1935) reports only two collections from the Lake Michigan drainage basin, both from the Milwaukee River in the southeastern corner of the state. His other records are distinctly northwestern in distribution.

7. **Northern Redhorse**—*Moxostoma aureolum* (LeSueur) T 12; P 13, 14; M 11. This species appeared in large, fast and clean water. A 13 inch fish was taken at station 12 on the Tomorrow-Waupaca. Greene (1935) records this species from none of the survey streams but has a record for the Big Eau Pleine River.

8. **Northern Hog Sucker**—*Hypentelium nigricans* (LeSueur) T 5 through 12; LW 4 through 14; P 4 through 12, 14; LEP 5. The hog sucker frequented swift, clean, and shallow water. In the three major rivers this species made up 2.1% of the total fish population. Greene (1935) reported this species from the Little Wolf, Tomorrow-Waupaca, Plover and the Little Eau Pleine.

9. **Common White Sucker**—*Catostomus c. commersonnii* (Lacépède) T 1, 2, 3, 5 through 12; LW 1 through 12, 14; P 2 through 14; LEP 1 through 9; LEC 1 through 5; H 1, 2, 3; M 11. This species is the most successful in Central Wisconsin waters. Table IX shows that the white sucker heads or is near the head of each column. Poundwise there is little question that it outstrips even the leaders. Many suckers were encountered which measured 12 to 16 inches. Suckers this size weigh between a pound and a pound and one-half. A half dozen such suckers equal the total weight presented by the 628 longnose dace which numerically head the list for the Tomorrow-Waupaca River.

The total of 2545 white suckers taken on the five rivers comprised 15% of the 16,918 fishes taken in the survey. It is estimated, however, that they exceeded in weight the total combined weight of all the other species. The white sucker was encountered mostly in the deep holes from which they would boil up by the score. In some instances we were able to recover but a small percentage of these

stunned fish. This led to a bias favoring the numbers of minnows and smaller fish species. Like the hog sucker this species shocked quickly, although such treatment was seldom fatal. The white sucker would keep poorly in the holding tank on hot days.

Greene (1935) claims this species as the most abundant of Wisconsin fishes. It appeared in 568 out of 1441 or 39% of his collections. In the 1958 survey it appeared in 56 out of 59 or 95% of the collections.

10. **Carp**—*Cyprinus carpio* (Linn.) T 5, 6, 7, 12; M 11, 12. The nine carp taken on the Tomorrow-Waupaca were found within short distances of impoundments. This "spillover" from artificial lakes was noted in other species. It is doubtful that any reproduction of carp takes place in the stream proper. The three fish taken at station 7 weighed 5 lbs. 11 oz., 7 lbs. 11 oz., and 11 lbs. 14 oz. The last measured 29¼ inches in length. Considerable carp reproduction has been reported from the Nelsonville pond between stations 4 and 5. Greene's distributional map (1935) shows this species from the southern half of the state with no record from Marathon, Wood and Portage counties.

11. **Central Stoneroller**—*Campostoma anomalum pullum* (Agassiz) T 6, 7, 8, 12; P 3, 4, 7, 8, 10, 12, 13, 14; LEP 5, 6; H 3. The largest populations were encountered in the lower reaches of the Tomorrow-Waupaca and the Plover rivers. At station 12 of the former, 14% of the total fish taken were of this species; on the Plover at station 14 they constituted 25% of the take. This minnow is found only in swift water and apparently is more successful in warmer water. It is the softest bodied of all minnows handled and disintegrates rapidly after death unless fixed with preservative. Greene (1935) has records from the Tomorrow-Waupaca and Plover rivers and Mill Creek. Although there were many stretches on the Little Wolf River qualifying for stoneroller habitat, neither survey recovered it there.

12. **Great Lakes Longnose Dace**—*Rhinichthys c. cataractae* (Valenciennes) T 6 through 12; LW 3 through 9, 13, 14; P 3, 4, 12, 13. The longnose dace is the most successful fish on the Tomorrow-Waupaca River, comprising 17% of the total catch. At station 6 the 174 individuals taken constituted 58% of the catch; at station 7, 68%. On the Little Wolf River the largest catch was taken at station 5 where 125 represented 25% of the total fish recovered. This dace was found only in clean, torrential waters where it often was the only fish taken. Occasional associate species are the hog sucker, stoneroller, common shiner and the hornyhead chub, the last two generally found at the edges of the fast water or in deep pools among the rocks. Greene (1935) took this minnow on the Tomorrow-

Waupaca and Little Wolf rivers. During the 1958 survey nineteen individuals were recovered from four stations on the Plover River.

13. **Western Blacknose Dace**—*Rhinichthys atratulus meleagris* (Agassiz) T 2 through 11; LW 2 through 8; P 2 through 13; LEP 1, 2; LEC 2. A sympatric species of the aforementioned dace, the blacknose is more generally distributed and successful in a greater variety of habitats. From the numerical data at hand it appears that the blacknose prefers cool, clean water flowing at a great variety of gradients. Almost 14% of all the fish taken on the Little Wolf River was of this species as well as 39% of the fish taken at station 3. At station 5 on the Tomorrow-Waupaca 235 individuals made up 44% of the station's catch.

The position of this minnow on the Little Eau Pleine and Little Eau Claire rivers is tenuous. Seven fish were found in the former and, in the latter, a single specimen. Greene (1935) lists it from the Tomorrow-Waupaca, Little Wolf and Plover rivers, and from Haymeadow Creek. The 1958 survey failed to reveal its presence in Haymeadow. It is felt that the paucity of minnows in this creek is due to the present large northern pike population. Subsequent careful sampling should be made to determine whether a remnant population still remains.

14. **Hornyhead Chub**—*Hybopsis biguttata* (Kirtland) T 6, 7, 8, 9, 12; LW 8 through 14; P 3, 4, 6, 7, 8, 10 through 14; LEP 2, 5 through 9. Table IX shows the horynhead present but not common in three rivers. The best ratio of hornyhead chub to the station catch was 50% recorded from station 6 on the Little Eau Pleine River. This minnow prefers swift clean water. On August 22 it was taken from over several nests at station 6 on the Little Wolf River. Two males, 5.3 and 6.0 inches in length, were in breeding habit; a gravid female measured 5.0 inches.

Although this species seems to do better in clean water, it was taken consistently in low numbers in muddy waters. That this is unusual is testified to by Hubbs and Cooper (1936) who point out "the absence of this species in muddy, silt-bottomed and stagnant waters." It was seldom taken with trout and was found mainly in the middle and lower sections of the streams surveyed in warmer water.

From external appearances the Little Eau Claire River should support this species since the gravel bottom appeared ideal for spawning purposes. The absence of the hornyhead probably is due to the intermittent nature of the stream. A similar situation exists in Boone County, Iowa, where Starrett (1950) reports the presence of this minnow in low numbers in the Des Moines and its tributaries. However it is totally absent in Squaw Creek, an inter-

mittent stream (Paloumpis, 1958). Greene (1935) reports this species from the same streams where taken in the 1958 survey.

15. **Northern Creek Chub**—*Semotilus a. atromaculatus* (Mitchill) T 1, 2, 3, 5 through 12; LW 1 through 9; P 2 through 13; LEP 1, 2, 3, 4, 6; LEC 1 through 5. Six percent of total fish on the above streams were from this species. Its frequency percent is 73% when calculated for all collections made. The creek chub was the third most commonly encountered fish in the survey. Several males with breeding tubercles were taken in late June and beginning July. Individuals were taken up to eight inches in length. The creek chub appeared to do best in clear cooler waters but it was found in warm, muddy waters in decreasing numbers. At station 3 on the Little Wolf River 143 individuals made up 44% of the station's catch. Greene (1935) found this minnow in 31% of his collections, second to the common white sucker (39%) which appeared most frequently.

16. **Northern Pearl Dace**—*Semotilus margarita nachtriebi* (Cox) T 1, 2, 3, 6; LW 1 through 6; P 2, 11; LEP 4; LEC 1, 2, 3. On the larger rivers there is good correlation between the presence of this species and the brook trout. Its presence on the Little Eau Pleine and the Little Eau Claire refutes such contention for an indicator species. Apparently its presence is not a function of low temperature as much as it is of small water. The pearl dace is found in greatest numbers in very narrow waters and is able to survive fairly well in intermittent water (as indicated in the discussion on the Little Eau Claire River). At station 2 over nine percent of the fish taken were of this species. The best catch was made at station 1 on the Tomorrow-Waupaca River where the 81 individuals made up 30.4% of the station catch. This incidentally was the station with the smallest average width. The water itself was obscured from view by an overgrowth from small willows. No current was discernible. Greene (1935) took this species on the upper Tomorrow-Waupaca and Plover rivers.

17. **Northern Redbelly Dace**—*Chrosomus eos* (Cope) T 1, 2, 3; LW 1, 2, 3; P 5, 9, 10, 11; LEP 1, 2, 3, 4; LEC 1, 2, 3. The range of this species correlated very well with the foregoing species. Its distribution favored small waters and on the intermittent Eau Claire River it made up 4.6% of all fish taken. Fifty-three specimens were taken at station 1 on the Little Eau Pleine River. This was 8.8% of all fish collected there. The majority (78%) of this species was collected from turbid water. Greene (1935) reports this species from the Little Eau Pleine River.

18. **Western Golden Shiner**—*Notemigonus crysoleucas auratus* (Rafinesque) T 9; LW 1; LEP 2, 3, 9; LEC 5; H 1. Primarily a lake

minnow, the golden shiner was represented in the summer catch by only 29 individuals. Fifteen of these were recorded from station 1 on Haymeadow Creek, amounting to 32% of the station's catch. Greene (1935) reported this minnow from the Plover River, Little Eau Pleine River and Mill Creek.

19. **Northern Fathead Minnow**—*Pimephales p. promelas* (Rafinesque) T 6; LW 1; LEP 1, 2, 3, 4; LEC 4. Only 24 specimens were taken during the summer. The five individuals recorded from station 6 of the Tomorrow-Waupaca probably represent escapes from bait minnow holding ponds one-half mile upstream from where the samples were taken. The heavy silt load of the upper stations of the Little Eau Pleine and the series of ponds which make up its course seem favorable habitat for fathead minnow production; however, only fifteen individuals were taken at four stations. Since this river is tapped heavily by bait dealers and since the fathead is a good hardy summer minnow, it may be that this species has suffered accordingly. Commercial over-exploitation of minnow population has been discussed by Eddy and Surber (1947). On the other hand many streams can sustain even greater exploitation (Brynildson, 1959). Greene (1935) reports this fish from the upper portion of Mill Creek.

20. **Bluntnose Minnow**—*Pimephales notatus* (Rafinesque) T 5, 6, 9, 10, 11, 12; LW 6 through 12; P 3 through 14; LEP 2, 4, 5, 7, 8, 9; LEC 4, 5; M 11, 12. Frequency in occurrence of this species is 59%. Although distributed throughout most of the streams except for the headwaters, the bluntnose is more common in the lower reaches. It is adapted to a variety of water temperatures and habitats. At station 14 on the Plover 322 bluntnose were taken in a total catch of 621 fish. This preponderance (53.5%) may be ascribed to man unwittingly abetting the fish's breeding requirements. This station is situated below an impoundment and the stream is flanked on the east bank by a city park. To keep the erosive effects of the river in tow, planks had been driven into the bank. The exposed ends of the planks are jutting several feet out into the water and are entirely under the water's surface. Schools of hundreds of bluntnose moved in and out from under the planks or through the openings surrounded by *Potamogeton sp.*. Since this minnow demands the under surface of a log, board or rock against which to deposit its eggs (Hubbs and Cooper, 1936), man in his soil-conservation move has promoted a bluntnose irruption. Other sizeable populations were encountered at station 12 on the Little Wolf (41.6%) and at station 8 on the Little Eau Pleine (32.2%). Greene (1935) records this species from all streams except Haymeadow Creek and the Tomorrow-Waupaca, although he found it in tributaries of the latter. The 1958 survey found 29 individuals of this species in the

Tomorrow-Waupaca, constituting 0.8% of the total fish population recovered. If the bluntnose population some 30 years ago was no greater then than it is now, it isn't difficult to understand why it was overlooked in Greene's two collections.

21. **Brassy Minnow**—*Hybognathus hankinsoni* (Hubbs) LW 5; LEP 1, 2, 3, 4, 8. The turbid pond-like pools of the Little Eau Pleine River produced 36 individuals or 1.0% of the total catch on that river. Greene (1935) reports this species only from the Big Eau Pleine River in this four-county area.

22. **Northern Common Shiner**—*Notropis cornutus frontalis* (Agassiz) T 2 through 12; LW 3 through 14; P 2 through 14; LEP 1 through 9; LEC 2, 3, 4, 5. The common shiner occurred in 85% of the summer's collections, outstripping all species of fish with the exception of the common white sucker. It was found under a wide variety of conditions—clean, cool, torrential water (station 3 of the Plover River) to muddy, warm, stagnant water (lower stations of the Little Eau Pleine and the Little Eau Claire rivers). River size apparently has little effect on its distribution. This species has been taken from a culvert a foot in diameter through which was flowing water from a warm lake at the rate of a gallon per second. However under excellent collecting conditions we failed to recover the common shiner at stations 1 on four rivers and at station 2 for the Little Wolf. The gravel necessary for breeding is found at all the above stations. What then are the limiting factors? Hubbs and Cooper (1936) write: "The rather limited spawning season extends from the latter part of May into June, and spawning probably rarely occurs at water temperatures lower than 60° to 65° F."

August temperatures at all headwaters stations were 66° or less (except for a 75° F. on the Tomorrow-Waupaca). If water temperatures even late in the season are at the lower breeding limits, then during the breeding season in May and June they probably are even lower. It appears then that for the most part headwaters stations are too cold to allow spawning. A 6.3-inch male in breeding habit was taken at station 6 on the Plover River, June 24th. Several gravid females were taken at the same time. Greene (1935) recorded its distribution throughout the area.

23. **Rosyface Shiner**—*Notropis rubellus* (Agassiz) T 9, 12; LW 9, 11, 14; P 12, 13; LEP 5. A minnow of medium or big clear and swift water, the rosyface shiner occurred in 14% of all collections. The 104 individuals belie this frequency, since they constitute but 0.6% of the total summer's catch. Ninety-three (93) individuals of the 104 were taken from two stations—71 at station 12 of the Tomorrow-Waupaca and 22 at station 14 of the Little Wolf, 17.9% and 11.2% respectively of the stations' total catches. This species

schools near the upper stratum of the water. This placed the rosyface above the most effective range of the electrodes which were slid along the stream bottom. Since minnows were among the most difficult fish to shock, the swimming habit of the rosyface undoubtedly worked in its favor. It is probable that the recovery rate of this minnow is lower than for any other member of its family. Several schools of this minnow numbering as large as the entire summer's catch were observed swimming past us. Greene (1935) reported this species from the Tomorrow-Waupaca and the Little Wolf rivers.

24. **Spotfin Shiner**—*Notropis spilopterus* (Cope) T 12; LW 10, 11, 12, 14. Two individuals were recorded from the Tomorrow-Waupaca, the remaining 26 from the Little Wolf. Sixteen fish were taken at station 11 on the latter. A 3 inch male in breeding habit was recovered at station 12 on July 22nd and a 4 inch male in breeding habit at station 11 on the same day. Greene (1935) reports this species from the lower Little Wolf River.

25. **Northern Blacknose Shiner**—*Notropis h. heterolepis* (Eigenmann and Eigenmann) T 1, 3; LW 1; P 1, 2; LEP 1, 2, 3, 4, 5, 7, 8, 9; LEC 3, 4; H 1. Greene (1935) writes: "Somewhat paradoxically this minnow inhabits smaller streams and lakes in Wisconsin but generally avoids the larger rivers." The 1958 survey found this species concentrated in the narrow headwaters of the Little Wolf and Plover or in rivers like the Little Eau Pleine and the Little Eau Claire which consist of a series of pools. These pools assume the character of the "smaller . . . lakes" which Greene refers to. This minnow was found in clear and muddy water, the coldest and the warmest water, in swift current and in still water. If the water is running the stream size must be small; if the water is quiet, the body of water may be considerable.

At station 2 on the Little Eau Pleine 143 blacknose shiners made up 19.1% of the station's catch; at station 4 one hundred and twenty-four made up 19.8% of the station's catch. The 45 individuals taken at station 1 on the Plover represented 31.3% of the station's catch; 39 fish at station 1 on the Little Wolf, 21.4%. Greene (1935) records this species on the lower Plover, middle Little Wolf, and lower Mill Creek.

26. **Northeastern Sand Shiner**—*Notropis deliciosus stramineus* (Cope) T 12; LW 11. The 24 individuals taken at station 12 on the Tomorrow-Waupaca constituted 6.1% of the station's catch. Greene (1935) reports no specimens for these streams.

27. **Central Bigmouth Shiner**—*Notropis d. dorsalis* (Agassiz) T 7, 10; P 8, 9, 10, 11, 13, 14; LEP 2, 4, 8; LEC 4. This species was taken in 20% of the 1958 collections. Twenty-seven fish at station 2

on the Little Eau Pleine comprised 3.6% of the station's catch; twenty-eight at station 4, 4.5%. Greene (1935) reports this species from the upper and lower portions of Mill Creek.

28. **Northern Mimic Shiner**—*Notropis v. volucellus* (Cope) T 12; LW 12; M 11, 12. This species appeared at only seven percent of the stations sampled. Primarily a lake species, in the streams where found the mimic was taken in big water. Of the 37 individuals collected 29 were taken at the lower end of Mill Creek. At this point the creek meets a lake-like backwater from the Wisconsin River. These minnows were travelling in the shallows in a closely-knit school. The take at station 12 on Mill Creek represented 51% of the station's total fish catch. Greene (1935) reports this species from the Little Wolf, Tomorrow-Waupaca and Mill Creek.

29. **Northern Brown Bullhead**—*Ictalurus n. nebulosus* (LeSueur) H 3. This species is reported on the basis of a single individual, 7.2 inches in length. Greene (1935) records this species only once in the four-county area. His sample was taken at the mouth of Mill Creek.

30. **Northern Yellow Bullhead**—*Ictalurus n. natalis* (LeSueur) T 6, 7; LW 14; LEP 5, 6, 7, 8; M 11. This species appeared in 14% of the collections. It occurred most frequently in deep still pools. The Tomorrow-Waupaca specimens were probably escapes from the impoundments found just above stations 6 and 7. Eight of the twenty individuals taken during the summer were recorded from station 5 on the Little Eau Pleine. They comprised 3.6% of the station catch. Greene's (1935) only record for this species in the four-county area was taken at the mouth of Mill Creek.

31. **Northern Black Bullhead**—*Ictalurus m. melas* (Rafinesque) P 5, 10; LEP 2, 3, 4, 5, 7, 8, 9; LEC 2, 4, 5; M 11, 12. This species appeared at 24% of the stations sampled. Sixty-five specimens were taken on the Little Eau Pleine; 23 or 3.3% at station 3. The 12 individuals taken at station 9 on the same river comprised 7.4% of the station's catch. Greene (1935) records the black bullhead from the lower Little Wolf, lower Haymeadow Creek and from the middle portion of the Little Eau Pleine.

32. **Stonecat**—*Noturus flavus* (Rafinesque) LW 9, 13, 14; P 4, 8, 10, 11, 12, 14; LEP 5, 6. The stonecat was encountered in clear, often fast, water in the vicinity of large rocks or boulders. It is primarily a fish of middle- or large-sized water and occurred at 19% of the stations sampled. Twenty-six individuals of the summer's catch (42) were taken on the Plover River. Twelve of the 26 were collected at station 14. Greene (1935) reports the stonecat from the lower portion of the Little Wolf River.

33. **Tadpole Madtom**—*Schilbeodes gyrinus* (Mitchill) T 6; LW 12; LEP 7, 8, 9; LEC 4; M 11. The tadpole madtom appeared in 12% of the collections. It was encountered most commonly in silty water. Seven of the 23 fish recorded for the summer were taken at station 11 on Mill Creek. They comprised 8.8% of the station's catch. Greene (1935) records this species from the mouth of Mill Creek.

34. **Central Mudminnow**—*Umbra limi* (Kirtland) T 1, 3; LW 1, 2, 11; P 10, 11, 13; LEP 1, 2, 3, 4, 5, 7, 8, 9; LEC 1 through 5; H 1, 2, 3. The mudminnow occurred at 41% of the stations sampled. This small fish preferred silty waters and was found most frequently at the vegetated edges of streams where the water was only three to five inches in depth. In such habitat they were virtually the only species taken. Apparently cold water temperatures are no drawback to the continuance of this species. On the Tomorrow-Waupaca seven individuals were recorded from station 1; on the Little Wolf three were recorded from stations 1 and 2. At station 3 on the Little Eau Pleine River 174 specimens comprised 25.2% of the station's catch; at station 3 of the Little Eau Claire, 245 specimens comprised 70.3% of the station's catch. This fish was the most successful on the intermittent Little Eau Claire, where it yielded 44.1% of all the fish taken from the river. Greene (1935) records this species from all streams with the exception of the Little Eau Pleine and the Little Eau Claire. He did not sample the latter.

35. **Northern Pike**—*Esox lucius* (Linn.) T 12; P 13; LEP 7, 8, 9; LEC 5; H 1, 3; M 11. This species appeared in 15% of the collections. Its distribution is probably more general than is indicated above. Because of its size and speed, individuals avoided our gear and recovery was poor. Several young four to five inches in length were taken on Haymeadow Creek. Greene (1935) records it from the lower parts of the Little Wolf River and Mill Creek.

36. **Yellow Perch**—*Perca flavescens* (Mitchill) T 5; LEP 7, 8, 9; LEC 4, 5; H 3. Six perch were taken on the Tomorrow-Waupaca River, probably spillover from the Nelsonville millpond. Forty-two (42) perch taken at station 9 of the Little Eau Pleine made up 25.9% of the station's catch. At station 5 of the Little Eau Claire 22 individuals constituted 15.8% of the station's fish. Greene (1935) reports this species from the mouth of Mill Creek, the upper Tomorrow-Waupaca and the middle and lower portions of the Little Wolf River.

37. **Yellow Walleye**—*Stizostedion v. vitreum* (Mitchill) M 12. This single record, based on a single specimen 10.2 inches long, in no wise portrays the distribution of this species in Central Wisconsin. Walleyes have been reported taken from the three major rivers

and from the Little Eau Pleine. Greene (1935) has no reports from the survey streams.

38. **Blackside Darter**—*Hadropterus maculatus* (Girard) T 11; LW 4 through 12, 14; P 3 through 11, 14; LEP 1 through 9; LEC 4, 5; H 1; M 11, 12. Taken at 58% of the stations, the blackside is the most successful member of its family next to the Johnny darter. The blackside was found in shallow, fast water, in deep, slow pools and even where the water became extremely silty and warm. Extremely small, cold water streams limit its distribution. Greene (1935) took this species from the Little Eau Pleine, Little Wolf and Mill Creek.

39. **Northern Logperch**—*Percina caprodes semifasciata* (DeKay) T 9, 12; LW 13, 14; LEC 5; M 12. Schools of this species were seen several times at stations 13 and 14 on the Little Wolf River. Forty-two (42) specimens from station 13 constituted 43.8% of the station's catch. The logperch requires medium to large-sized water. Greene (1935) reports this species from the lower portion of the Little Wolf River.

40. **Central Johnny Darter**—*Etheostoma n. nigrum* (Rafinesque) T 2, 4, 5, 6, 8 through 12; LW 4, 5, 6, 7, 8, 10; P 3 through 14; LEP all stations except 6; LEC 2, 3, 4, 5; H 1; M 11. The Johnny darter was taken at 70% of the collection sites under a wide variety of water conditions. Like the blackside darter this species was commonly taken in slow water over mud or sand—habitat not frequented by the other members of the darter group. At station 2 on the Tomorrow-Waupaca 65, or 19.8% of the station's fish were of this species. It constituted over 5% of all the fish handled in the survey. Greene (1935) does not record this species from the Little Eau Pleine.

41. **Least Darter**—*Etheostoma microperca* (Jordan & Gilbert) P 13. Two individuals taken on June 23, 1.3 inches in length, are the only record we have of this species, although subsequent trips were made to the same station in attempts to recover more specimens. Greene (1935) did not record the least darter from the four-county area. He found it most frequently in the waters of the extreme southeastern corner of the state and this abundance continues down into the northeastern corner of Illinois (Forbes and Richardson, 1908). It is reported as very rare from the remainder of Illinois.

42. **Eastern Banded Darter**—*Etheostoma z. zonale* (Cope) T 7, 9, 10, 11, 12; LW 5 through 11, 13, 14; P 4 through 12, 14. This species appeared in 41% of the collections and was a fairly common darter in medium-sized to large swift water with clean gravel- or rubble-swept bottom. Greene's (1935) records include only the

downstream portions of the Tomorrow-Waupaca and the Little Wolf rivers.

43. **Rainbow Darter**—*Etheostoma caeruleum* (Storer) T 9, 10, 12; P 4 through 14; LEP 5, 6. This species appeared in 27% of the collections. Its habitat requirements are very much the same as those of the preceding species although the rainbow darter seemed to frequent heavier rubble more often. Both darters were recovered most frequently from water a foot or less in depth. At station 12 on the Tomorrow-Waupaca 48 individuals constituted 12.1% of the station's catch. The movement northward of this species in the Lake Michigan watershed was predicted by Greene (1935) who records this species in the upper Fox waterway as a form which apparently had crossed over the divide from the Wisconsin system at Portage. If this species continues its spread, it should be found in the Little Wolf shortly. Greene (1935) reports this species from the lower portions of the Plover River and Mill Creek.

44. **Iowa Darter**—*Etheostoma exile* (Girard) LW 1, 6; LEP 7, 9; LEC 2, 3, 4, 5. The Iowa darter was taken from slow, often turbid, water under great extremes in water temperatures. Forty-eight individuals from station 1 on the Little Wolf made up 26.4% of the total catch at that station. Greene (1935) records this species from the middle portion of the Plover River.

45. **Striped Fantail**—*Etheostoma flabellare lineolatum* (Agassiz) T 2, 10; LW 10; P 3 through 14; LEP 5, 6; LEC 5; M 12. The fantail was taken in 32% of the collections. Shallow, clear and swift water over gravel and rubble provide the demands of the species. Sixty (60) specimens, taken at station 6 on the Plover River, constituted 13.8% of the station's catch. Many of the stations which were sampled on the Tomorrow-Waupaca and Little Wolf rivers and which appeared to be typical fantail water failed to yield the species in our survey. No ready explanation is available to account for this discontinuity of distribution. Greene (1935) records this species for the Plover, Tomorrow-Waupaca, Little Wolf and lower Mill Creek.

46. **Northern Smallmouth Bass**—*Micropterus d. dolomieu* (Lacépède) LW 9, 10, 12, 13, 14; P 13, 14; LEP 5, 6, 9. The smallmouth appeared in 17% of the collections. It was taken generally from fast, deep holes in clear water. The slow, highly turbid water at station 9 on the Little Eau Pleine produced a single fry. Fourteen individuals taken at station 6 on the same river constituted 9.3% of the station's catch. Greene (1935) records a collection at the mouth of Mill Creek.

47. **Northern Largemouth Bass**—*Micropterus s. salmoides* (Lacépède) T 7; P 12; M 12. Although a common resident of the

millponds, this form was only taken three times during the survey in flowing water. The Plover River record is based on a 3.3 inch specimen picked up dead and it probably represents a spillover from the impoundment just upstream. Greene (1935) reports this species from lower Mill Creek and the middle portion of the Little Wolf.

48. **Pumpkinseed**—*Lepomis gibbosus* (Linn.) T 9; LW 1, 2; P 10, 12, 14; LEP 3, 5, 6, 7, 8; LEC 4, 5. The pumpkinseed along with the rock bass were the most successfully distributed members of the sunfish family. Fifty-three (53) pumpkinseeds were taken at 22% of the stations under a great variety of temperature and turbidity conditions. At station 1 on the Little Wolf nineteen (19) individuals made up 10.4% of the station's catch. Greene (1935) collected this species on the mid-portion of the Little Wolf.

49. **Common Bluegill**—*Lepomis m. machrochirus* (Rafinesque) T 3; LW 12; P 3; LEP 9; M 12. A total of 15 individuals were taken in the survey. Like the largemouth, this species is a product of ponds. The seven individuals recorded at station 12 on the Little Wolf were taken from a small weed-filled impoundment. Greene (1935) took a sample from the mid-portion of the Little Wolf. Another record based on literature or report is listed for the mouth of the Plover.

50. **Northern Rock Bass**—*Ambloplites r. rupestris* (Rafinesque) LW 7 through 11, 13, 14; LEP 2, 4, 5, 6; M 11, 12. This species appeared in 22% of the samples. One hundred and seventy-eight (178) individuals were taken on the Little Wolf; the 40 collected at station 8 constituted 13.0% of the station's catch. This species was generally taken in clear fast water in the vicinity of heavy rubble and boulders. Greene (1935) records this species above the mid-part of the Little Eau Pleine, at the mouths of Mill Creek and the Little Wolf. Although there are likely-appearing rock bass waters on the Plover and Tomorrow-Waupaca rivers, neither Greene's nor the present survey turned up a single individual of this species.

51. **Northern Mottled Sculpin**—*Cottus b. bairdii* (Girard) T 1 through 7, 9, 10, 11; LW 1 through 8; P 1, 2, 3, 7, 13. The northern muddler was taken at 39% of the survey stations. Although this species is often considered an indicator species for trout, there is evidence that it can tolerate higher temperatures than the most temperature-tolerant trout, the rainbow. Found mostly on clear, cool, gravel-strewn bottoms, the muddler frequently drifted out from under boulders or other natural shelters. This species constituted 11.2% (411 individuals) of all the fish taken on the Tomorrow-Waupaca River; at station 4, the 127 specimens com-

prised 76.1% of the station's catch. Greene (1935) collected this species on the upper Tomorrow, along the length of the Little Wolf and at the mouth of the Plover.

52. **Brook Stickleback**—*Eucalia inconstans* (Kirtland) T 3, 5; LW 1, 6; P 3, 11; LEP 1, 2, 3, 4, 9; LEC 1, 2, 3. The stickleback appeared in 24% of all the collections. Although taken in small, cool headwaters and so conforming with the "brook" portion of its name, this species occurred in greater numbers in the turbid pond-like waters of the Little Eau Pleine. Eight hundred and fifty-one (851) individuals were taken from this river out of a total of 892 collected during the survey. Some workers are beginning to recognize that mushrooming numbers of this species are an indication of water pollution. The 378 individuals collected at station 1 on the Little Eau Pleine represented 62.5% of the station's catch. On the same river the stickleback made up 23.3% of the total catch.

This species survives under intermittent stream conditions. On the Little Eau Claire on August 7, 1958, the stickleback was recovered from a warm pool (76.4° F.) with extreme depth of 22.3 inches along with the common shiner, common white sucker and northern creek chub. Greene (1935) collected the stickleback from the upper portion of Mill Creek and lower Little Wolf River.

53. **American Burbot**—*Lota lota lacustris* (Walbaum) H 3. The presence of the lawyer is based on a single specimen, 3.5 inches in length. Greene (1935) records this species from the mouth of the Plover and the middle and lower parts of the Little Wolf.

Addenda

Three additional species were taken in the Tomorrow-Waupaca at station 7 in April and May, 1959. The first two of the following are cyprinids and the third, a centrarchid:

54. **Southern Redbelly Dace**—*Chrosomus erythrogaster* (Rafinesque) T 7. A single specimen, 2.5 inches long, was recovered on April 25, 1959. Another specimen, a gravid female 3.2 inches long, was taken on May 4, 1959. Greene (1935) reports this species from the lower part of the Plover River.

55. **Lake Emerald Shiner**—*Notropis atherinoides acutus* (Lapham) T 7. An individual 4.5 inches in length was taken from a deep hole on April 25, 1959. It is felt that this minnow is an escape from the bait minnow ponds located at Amherst. During the winter months the dealer dealt principally in this species which was netted in quantities from Lake Michigan ports. Greene (1935) reports that this species is seldom taken from smaller streams. He has no records from the four-county area.

56. **Black Crappie**—*Pomoxis nigromaculatus* (LeSueur) T 7. A small crappie 3.1 inches in length was taken from a slow-moving deep pool on April 25, 1959. This individual is undoubtedly a spill-over from the Amherst pond. Greene (1935) records this species from Western and Southern Wisconsin. He has no record from the survey streams.

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THE ELATERIDAE OF WISCONSIN[1]

I. A List of the Species Found in Wisconsin and Keys to the Identification of Genera of Adults and Larvae

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The click beetles and wireworms which make up the family Elateridae are familiar insects to a large part of the rural population of Wisconsin. In most cases the adult and larvae are not recognized as different stages of the same insect, but each claims attention in its own way. The adults are known for their ability, when placed on their backs, to spring into the air with an audible click which has earned them their common name. On the other hand, the larvae are best known as destroyers of newly planted corn and potatoes and are the cause of replanting or abandonment of certain fields.

Previous published work on the Elateridae in Wisconsin is scanty and consists mainly of short notes in Extension publications or in the Annual Reports of the Wisconsin Agricultural Experiment Station.

Similar work on the Elateridae of other states has been done in Indiana by Blatchley (1910), in Maine by Hawkins (1936), in Pennsylvania by Thomas (1941), in New York by Dietrich (1945), in South Dakota by Severin (1949) and in Georgia by Fattig (1951).

The purpose in making the present study was twofold. The first objective was to provide a means of recognizing adult and larval Elaterids occurring in Wisconsin. This includes (1) keys constructed for the identification of genera and species by means of both adult and larval characteristics and (2) descriptions of the adults and larvae of each species. An attempt has been made to present this information in a form that will be equally acceptable to taxonomist, student, and fieldman. The second aim was to provide information about the biology of the individual species since such knowledge is fundamental to the development of suitable con-

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[1] Contributions from the Department of Entomology, Wisconsin Agricultural Experiment Station, Madison, Wisconsin, and the Entomology Faculty, Division of Biological Sciences, North Carolina State College, Raleigh, N. C. Published with the approval of the Director of Research, North Carolina Agricultural Experiment Station as Paper No. 901 of the Journal Series.

[2] The author wishes to acknowledge the assistance of Judith B. Bain and Joyce A. Hunt in preparing the drawings and of Merton C. Lane who reviewed the manuscript.

trol procedures and to a clear understanding of the true relationships of the accepted taxonomic groups. Information on the biology of these insects has been obtained through observations in the field, by rearing of the immature forms and from published reports of other workers.

The first section of this report deals mainly with recognition of the genera. Discussion of specific characteristics and biology is to be taken up in subsequent sections.

Characteristics of the Elateridae

The adult click beetles vary greatly in size but are quite constant in general shape, their elongate form and the often prolonged hind angles of the pronotum making them easily recognizable. The elytra are rigidly constructed, narrowing gradually posteriorly, and the hind wings are well developed. The tarsi and abdomen are five segmented and there is always present a prosternal prolongation or process which fits into a cavity in the mesosternum. Adult members of this family differ from those of other closely related families which also possess a prosternal prolongation and mesosternal groove in that the Elaterids have the prothorax loosely joined to the mesothorax. This permits the movement necessary for making the snapping leap into the air when the beetles are placed on their backs.

The antennae are more or less serrate and are generally 11-segmented; in a few genera a 12th segment may be present. The mouthparts are adapted for chewing, with the mandibles quite small and retracted.

The legs are slender; the fore coxae are spherical with the cavi- the open behind, while the hind coxae are transverse and contiguous.

Wireworms also vary considerably in size but most species are readily recognized by their hard, shining bodies varying in color from pale yellow to dark red-brown and bearing only three pairs of five-segmented thoracic legs. The labrum is fused to the clypeus and forms a toothlike projection or projections known as the nasale. The clypeus is not distinctly delimited posteriorly and the fronto-clypeal area is usually lyre-shaped and quite characteristic of the family.

The abdomen is apparently nine- but actually ten-segmented, the tenth segment appearing as a projection from the ventral surface of the ninth and bearing the anus. The ninth segment is extremely variable in shape; sometimes with horn-like terminal processes known as urogomphi surrounding a caudal notch.

Elaterid eggs are small, generally less than 0.5 mm. in diameter, and almost spherical. They are usually white, sometimes with a bluish or yellow tinge.

The pupae are dull yellow to white and have conspicuous spine-like processes at the anterior angles of the prothorax.

Species of Elateridae Found in Wisconsin

The specimens studied include representatives in the collection of The United States National Museum, the Milwaukee Public Museum, the William S. Marshall collection and the collection of the Department of Entomology at the University of Wisconsin, those in the author's collection, and larval specimens belonging to Dr. H. H. Jewett. In addition, a large number of specimens collected by Dr. R. D. Shenefelt and associates, was available for study. The literature was reviewed for references to the occurrence or possible occurrence of various species in Wisconsin or neighboring states.

Studies of Elaterid larvae by Hyslop (1917), Glen *et al* (1943), Van Emden (1945), Jewett (1946) and Glen (1950) provided information essential to an understanding of the characteristics of the genera occurring in Wisconsin.

Following is a list of the species occurring or probably occurring in Wisconsin, the letter "P" after a name indicating probable, though unreported occurrence:

LACON Castelnau

L. auroratus (Say)
L. avitus (Say)
L. brevicornis (Lec.)
L. discoideus (Web.)
L. marmoratus (Fab.)
L. obtectus (Say)

COLAULON Arnett

C. rectangularis (Say)

ALAUS Eschscholtz

A. myops (Fab.)
A. oculatus (L.)

CONODERUS Eschscholtz

C. auritus (Hbst.)
C. vespertinus (Fab.)

DRASTERIUS Eschscholtz

D. dorsalis (Say)

PITYOBIUS Leconte

P. anguinus (Lec.)

LIMONIUS Eschscholtz

L. aeger Lec.
L. anceps Lec.
L. aurifer Lec.
L. auripilis (Say)
L. basilaris (Say)
L. confusus Lec. P
L. ectypus (Say)
L. griseus (Beauv.)
L. plebejus (Say)
L. quercinus (Say)
L. rudis Brown

ATHOUS Eschscholtz

A. acanthus (Say)
A. brightwelli (Kby.)
A. cucullatus (Say)
A. rufifrons (Rand.)
A. scapularis (Say)

DENTICOLLIS Piller & Mitterpacker
D. denticornis (Kby.)
D. productus (Rand)

CTENICERA Latreille
C. aethiops (Hbst.)
C. appressa (Rand.)
C. appropinquans (Rand.)
C. arata (Lec.) P
C. cylindriformis (Hbst.)
C. darlingtoni (Brown)
C. fallax (Say) P
C. falsifica (Lec.)
C. fulvipes (Bland)
C. hamata (Say)
C. hieroglyphica (Say)
C. inflata (Say)
C. insidiosa (Lec.) P
C. kendalli (Kby.)
C. lobata tarsalis (Melsh.)
C. mediana (Germ.)
C. mendax (Lec.)
C. nitidula (Lec.)
C. propola (Lec.)
C. pyrrhos (Hbst.)
C. resplendens (Esch.)
C. sjaelandica (Mueller)
C. spinosa (Lec.)
C. splendens (Zeig.)
C. sulcicollis (Say)
C. triundulata (Rand.)
C. vernalis (Hentz)

HEMICREPIDIUS Germar
H. bilobatus (Say)
H. decoloratus (Say)
H. memnonius (Hbst.)

HYPOLITHUS Eschscholtz
H. abbreviatus (Say)

NEGASTRIUS Thomson
N. choris (Say)
N. exiguus (Rand.)
N. obliquatulus (Melsh.)
N. tumescens (Lec.)

PARALLELOSTETHUS Schwarz
P. attenuatus (Say)

ELATER Linnaeus
E. abruptus Say

OXYGONUS Leconte
O. obesus (Say)

SERICUS Eschscholtz
S. honestus (Rand.)
S. incongruus (Lec.)
S. silaceous (Say)
S. viridanus (Say)

DALOPIUS Eschscholtz
D. cognatus Brown
D. pallidus Brown
D. vagus Brown

AGRIOTES Eschscholtz
A. arcanus Brown
A. avulsus (Lec.)
A. fucosus (Lec.)
A. insanus Cand.
A. isabellinus (Melsh.)
A. limosus (Lec.)
A. mancus (Say)
A. oblongicollis (Melsh.)
A. pubescens (Melsh.)
A. quebecensis Brown
A. stabilis (Lec.)

AGRIOTELLA Brown
A. bigeminata (Rand.)

GLYPHONYX Candeze
G. recticollis (Say) ?

AMPEDUS Dejean
A. aereolatus (Say)
A. apicatus (Say)
A. impolitus (Melsh.)
A. linteus (Say)
A. luctuosus (Lec.)
A. manipularis (Cand.)
A. melanotoides Brown

A. militaris (Harris)
A. mixtus (Hbst.)
A. nigricans Germ.
A. nigricollis (Hbst.)
A. nigrinus (Hbst.)
A. pedalis Germ.
A. rubricus (Say)
A. sanguinipennis (Say)
A. semicinctus (Rand.)
A. socer (Lec.)
A. verticinus (Beauv.)
A. vitiosus (Lec.)

MEGAPENTHES Kiesenwetter

M. stigmosus (Lec.)

MELANOTUS Eschscholtz

M. americanus (Hbst.)
M. castanipes (Payk.)
M. communis (Gyll.)
M. cribulosus (Lec.)
M. depressus (Melsh.)
M. divarcarinus Blatch.
M. fissilis (Say)
M. ignobilis (Melsh.)
M. morosus Cand.
M. pertinax (Say)
M. tenax (Say)
M. trapezoideus (Lec.)

CARDIOPHORUS Eschscholtz

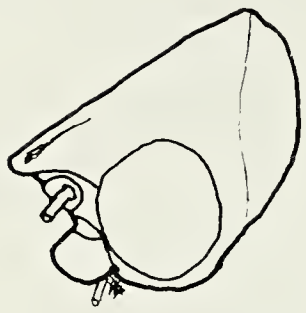
C. convexulus (Say)
C. convexus (Say)
C. gagates Er.

HORISTONOTUS Candeze

H. curiatus (Say)

Key to the Wisconsin Genera of Adult Elateridae

1. Front flattened or concave, facing obliquely dorsally with anterior margin not extending downward below the level of the eyes and without oblique clypeal carinae beneath; mouthparts directed and usually projecting anteriorly (Fig. 1) (Pyrophorinae) ---------- 3
   Front convex, facing anteriorly usually with anterior margin extending downward below the level of the eyes or carinate and supported beneath by converging oblique carinae (Fig. 2); mouthparts not projecting anteriorly (Fig. 3) ---- 2
2. Scutellum, or posterior portion thereof, heartshaped (Fig. 8) (Cardiophorinae) ---------- 25
   Scutellum variable in shape, not heartshaped (Fig. 5) (Elaterinae) ---------- 16
3. Hind coxae with ventral plates broad at inner third; broader in dilated portion than hind femora (Figs. 10, 12) -------- 4
   Hind coxae with ventral plates relatively narrow at inner third; as narrow or narrower in dilated portion than hind femora (Fig. 11) ---------- 9
4. Hind coxae truncate at outer ends (Fig. 10) prosternal sutures straight or concave, diverging near coxae (Figs. 13, 15) (Pyrophorini) ---------- 5
   Hind coxae pointed at outer ends (Fig. 12) prosternal sutures convex, converging toward coxae (Figs. 16, 18) (Negastriini = Hypnoidini) ---------- 15



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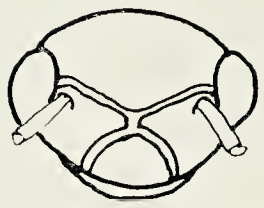

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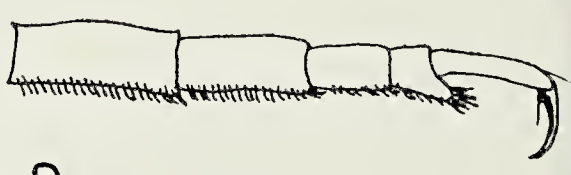

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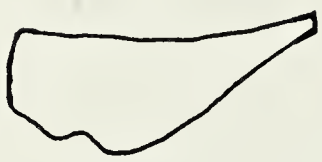

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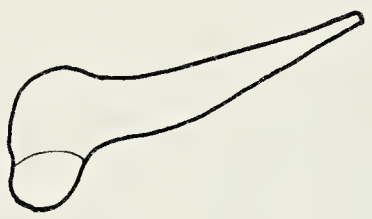

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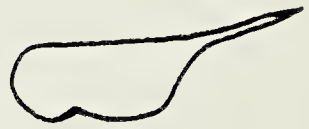

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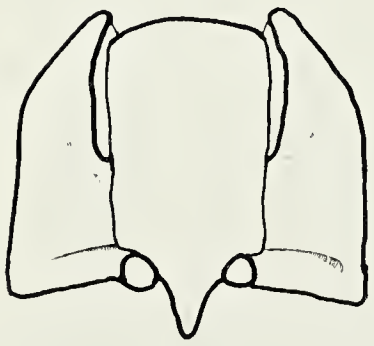

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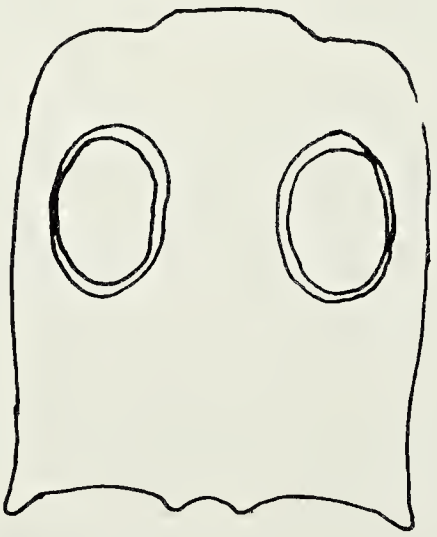

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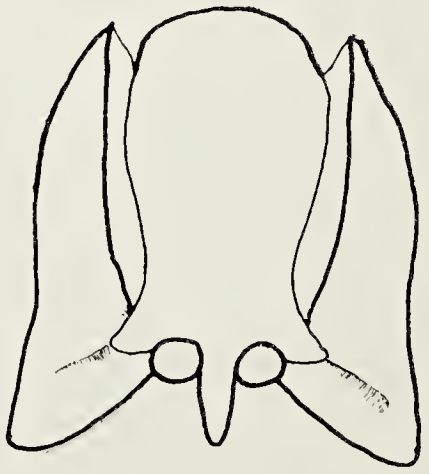

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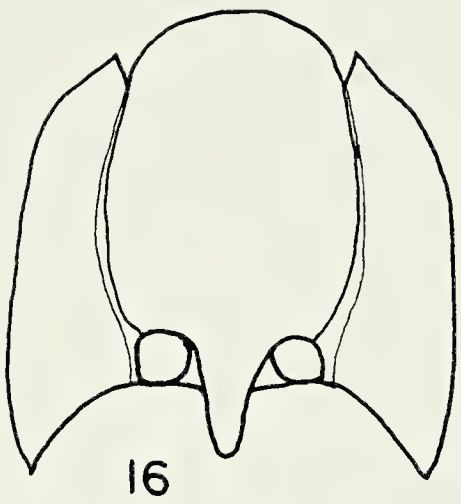
PLATE I

Adult Structures

Figure 1. *Pityobius anguinus* head, lateral.
2. *Glyphonyx* sp. head, frontal.
3. *Agriotes stabilis* head, lateral.
4. *Limonius basilaris* hind tarsus, lateral.
5. *Elater abruptus* scutellum.
6. *Conoderus auritus* hind tarsus, lateral.
7. *Hemicrepidius memnonius* hind tarsus, lateral.
8. *Cardiophorus gagates* scutellum.
9. *Drasterius dorsalis* hind tarsus, lateral.
10. *Drasterius dorsalis* ventral plate of hind coxa.
11. *Denticollis denticornis* ventral plate of hind coxa.
12. *Hypolithus abbreviatus* ventral plate of hind coxa.
13. *Colaulon rectangularis* prothorax, ventral.
14. *Alaus oculatus* pronotum.
15. *Lacon discoideus* prothorax, ventral.



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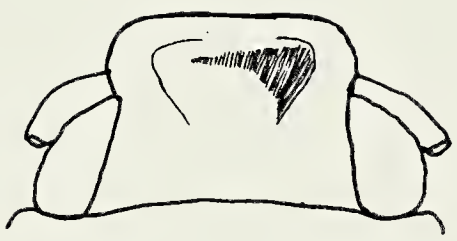

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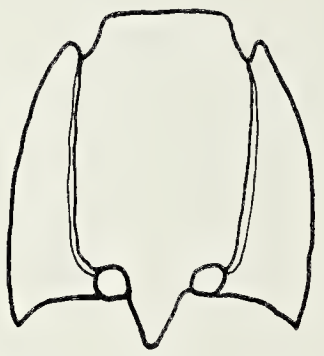

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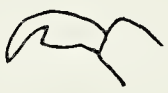

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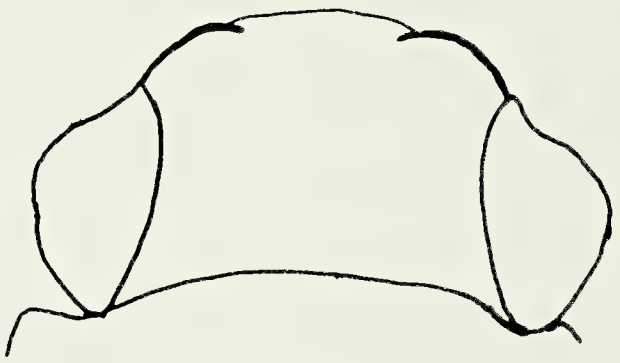

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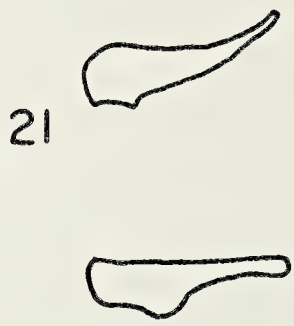

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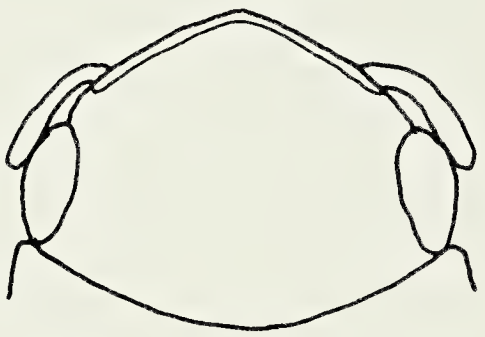

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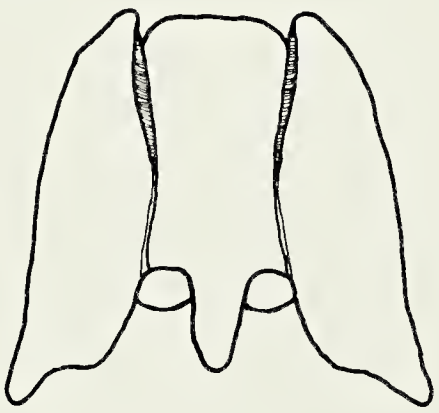

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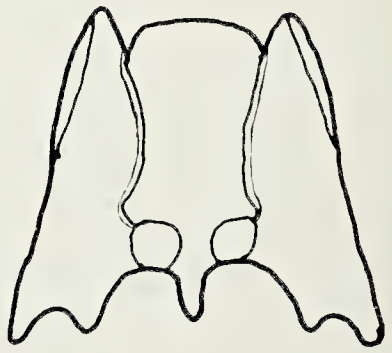

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PLATE II

Adult Structures

Figure 16. *Hypolithus abbreviatus* prothorax, ventral.
17. *Athous cucullatus* head, dorsal.
18. *Negastrius choris* prothorax, ventral.
19. *Oxygonus obesus* tarsal claw.
20. *Ctenicera pyrrhos* head, dorsal.
21. *Melanotus fissilis* ventral plate of hind coxa.
22. *Dalopius pallidus* ventral plate of hind coxa.
23. *Melanotus fissilis* tarsal claw.
24. *Megapenthes limbalis* head, dorsal.
25. *Elater abruptus* ventral plate of hind coxa.
26. *Ampedus linteus* prothorax, ventral.
27. *Parallelostethus attenuatus* mesosternal cavity, ventral.
28. *Megapenthes limbalis* prothorax, ventral.

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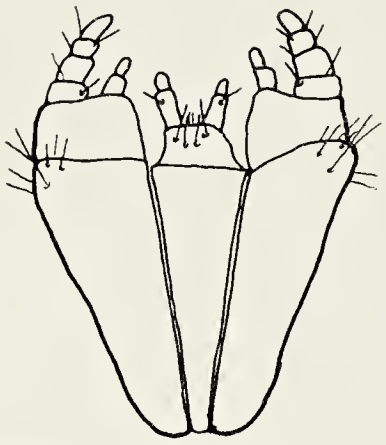

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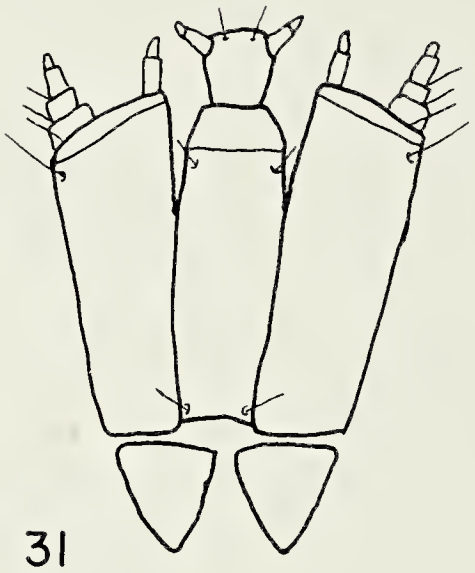

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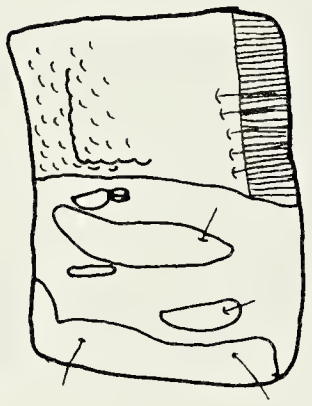

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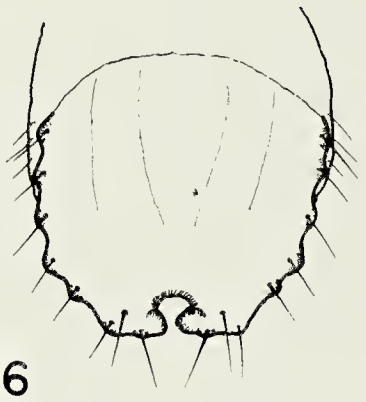

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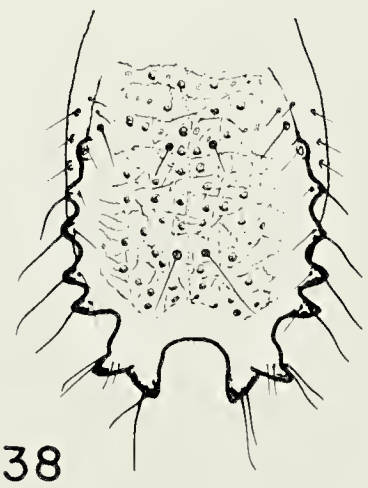

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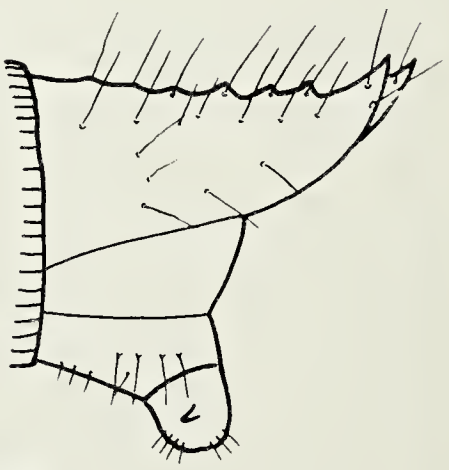

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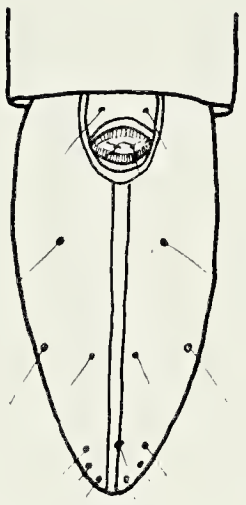
PLATE III

Larvae

FIGURE 29. *Melanotus communis* larva, dorsal.
30. *Drasterius dorsalis* ventral mouthparts.
31. *Ctenicera kendalli* ventral mouthparts.
32. *Cardiophorus* sp. larva, dorsal.
33. *Conoderus auritus* fronto-clypeal sclerite.
34. *Ctenicera kendalli* presternal area.
35. *Hemicrepidius bilobatus* sixth abdominal segment, lateral.
36. *Limonius* sp. ninth abdominal segment, dorsal.
37. *Alaus myops* ninth and tenth abdominal segments, lateral.
38. *Lacon marmoratus* ninth abdominal segment, dorsal.
39. *Conoderus auritus* ninth and tenth abdominal segments, lateral.



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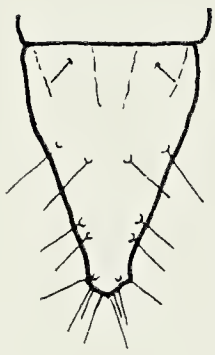

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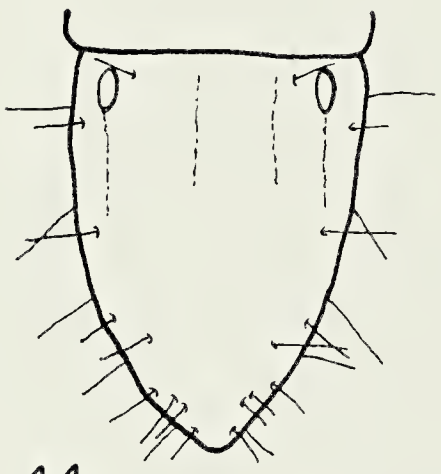

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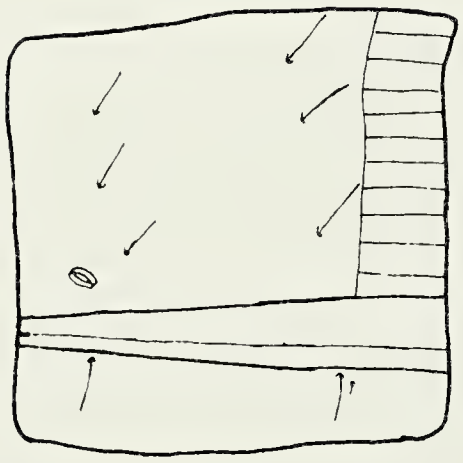

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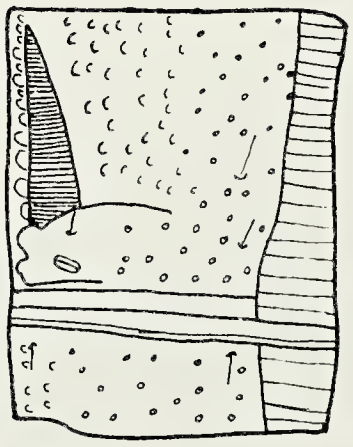

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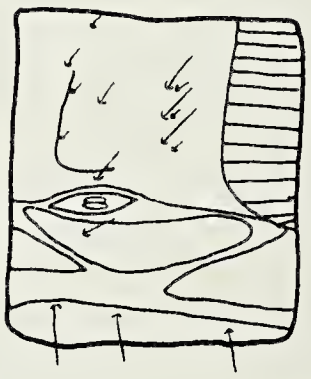

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PLATE IV

Larvae

FIGURE 40. *Elater abruptus* ninth and tenth abdominal segments, ventral.
41. *Dalopius pallidus* ninth abdominal segment, dorsal.
42. *Megapenthes limbalis* ninth and tenth abdominal segments, ventral.
43. *Elater abruptus* antenna.
44. *Agriotes mancus* ninth abdominal segment, dorsal.
45. *Parallelostethus attenuatus* antenna.
46. *Agriotes mancus* sixth abdominal segment, lateral.
47. *Ampedus nigricollis* sixth abdominal segment, lateral.
48. *Hypolithus abbreviatus* sixth abdominal segment, lateral.

5. Prosternal sutures forming antennal grooves (Figs. 13, 15) (Agrypnina) ---------- 6
   Prosternal sutures normal, no antennal grooves ---------- 7
6. Pronotum with deep linear impressions; antennal groove occupying entire prosternal suture (Fig. 15) ---------- *Lacon*
   Pronotum without deep impressions; antennal groove abbreviated (Fig. 13) ---------- *Colaulon*
7. Pronotum with eyelike spots (Fig. 14); tarsal claws with a long pencil of bristles at base of each ---------- *Alaus*
   Pronotum without eyelike spots; tarsal claws without a pencil of bristles (Conoderina) ---------- 8
8. Lobe on fourth tarsal segment prominent, projecting beneath fifth for at least one-fourth the length of the fifth segment (Fig. 6) ---------- *Conoderus*
   Lobed process on fourth tarsal segment short and broad, projecting only slightly beneath the fifth (Fig. 9) ---- *Drasterius*
9. Antennae 12-segmented (Pityobini) ---------- *Pityobius*
   Antenna 11-segmented (Denticollini = Lepturoidini) ---- 10
10. Tarsal claws simple (Fig. 4) ---------- 11
    Tarsal claws with a stout tooth at base (Fig. 19) -- *Oxygonus*
11. Prosternal lobe extending forward well beyond hind margins of eyes; with appearance of typical Elaterid ---------- 12
    Prosternal lobe short, not extending forward beyond hind margins of eyes; resembling a Cantharid -------- *Denticollis*
12. Margin of front straight, uniformly elevated (Fig. 17) ---- 13
    Margin of front curved, usually depressed in middle (Fig. 20) ---------- 14
13. First two tarsal segments subequal in length (Fig. 4) *Limonius*
    First tarsal segment distinctly longer than second ----*Athous*
14. Second and third tarsal segments lobed (Fig. 7) ---------- *Hemicrepidius*
    Tarsal segments without lobes ---------- *Ctenicera*
15. Prosternal sutures subarcuate, converging gradually toward anterior lobe and coxal cavities (Fig. 16) -------- *Hypolithus*
    Prosternal sutures converging suddenly at base of anterior lobe and at coxal cavities (Fig. 18) ---------- *Negastrius*
16. Hind coxal plates with posterior margins sinuate (Fig. 22); propleural margins concave or excavated along prosternal sutures, at least anteriorly (Agriotini) ---------- 21
    Hind coxal plates with posterior margins angulate (Figs. 21, 25); propleural margins variable along prosternal sutures ---------- 17
17. Propleural margins depressed or excavated along prosternal sutures, at least anteriorly (Fig. 26) ---------- 24
    Propleural margins not depressed or excavated along prosternal sutures (Fig. 28) ---------- 18

18. Margin of front elevated above the clypeus (Fig. 24) ---------- *Megapenthes*
    Margin of front not elevated in middle above clypeus (Elaterini) ---------- 19
19. Hind coxal plates with a distinct angle or tooth at widest point (Fig. 25); length 15 mm. or more ---------- 20
    Hind coxal plates with a blunt or indistinct angle at widest point; length, less than 15 mm. ---------- *Sericus*
20. Sides of mesosternal cavity parallel (Fig. 27); pronotum piceous ---------- *Parallelostethus*
    Sides of mesosternal cavity convergent posteriorly; pronotum black ---------- *Elater*
21. Tarsal claws pectinate ---------- *Glyphonyx*
    Tarsal claws simple ---------- 22
22. Lateral margins of prothorax inferior anteriorly ---------- 23
    Lateral margins straight, not inferior anteriorly --- *Dalopius*
23. Margin of front elevated; prosternal lobe extending beyond anterior ends of propleura ---------- *Agriotella*
    Margin of front not elevated (Fig. 3); prosternal lobe not extending beyond anterior ends of propleura ---------- *Agriotes*
24. Tarsal claws pectinate (Fig. 23) (Melanotini) ---- *Melanotus*
    Tarsal claws simple (Ampedini) ---------- *Ampedus*
25. Pronotum without a distinct lateral margin, apparent lateral margin visible posteriorly from ventral side ---- *Cardiophorus*
    Pronotum with lateral margin distinct posteriorly and visible dorsally ---------- *Horistonotus*

Key to the Wisconsin Genera of Larval Elateridae[3]

1. Ninth abdominal segment with a median caudal notch (Figs. 36, 38) (Pyrophorinae) ---------- 3
   Ninth abdominal segment without a median caudal notch (Figs. 29, 32, 40, 41, 42, 44) ---------- 2
2. Abdomen entirely soft-skinned; abdominal segments subdivided into 2 or 3 ringlike divisions (Fig. 32) (Cardiophorinae) ---------- 26
   Abdomen partially or completely sclerotized; abdominal segments not subdivided as above (Fig. 29) (Elaterinae) ---- 17
3. Submentum triangular; bases of stipes contiguous (Fig. 30) 4
   Submentum not triangular; bases of stipes well separated (Fig. 31) (Denticollini = Lepturoidini) ---------- 9
4. Anal hooks present on tenth abdominal segment (Figs. 37, 39) (Pyrophorini) ---------- 5
   Anal hooks absent, armature consisting of a narrow ridged band on each side of tenth segment (Pityobini) ---- *Pityobius*

[3] The larvae of *Oxygonus* are unknown.

5. Dorsum of head with a prominent longitudinal groove extending from near frontal suture to hind margin of head on either side; with short spines in addition to anal hooks on tenth abdominal segment (Fig. 37) (Hemirhipina) ____ *Alaus*
   Dorsum of head without extensive longitudinal grooves, sometimes with short grooves or rows of setae posteriorly; without short spines in addition to anal hooks on tenth segment ____ 6
6. Anal hooks long and prominent, extending to or beyond tip of tenth abdominal segment (Agrypnina) ____ 7
   Anal hooks short and inconspicuous, not extending to tip of tenth abdominal segment (Fig. 39) (Conoderina) ____ 8
7. Dorsum of ninth abdominal segment covered with small tubercles (Fig. 38) ____ *Lacon*
   Dorsum of ninth abdominal segment without tubercles ____ *Colaulon*?
8. Frons truncate at base (Fig. 33) ____ *Conoderus*
   Frons tapering to a blunt point at base ____ *Drasterius*
9. First 8 abdominal segments conspicuously sculptured or pitted (Fig. 35) ____ 14
   First 8 abdominal segments smooth; sparsely or finely punctured ____ 10
10. Nasale tridentate or if consisting of one triple-pointed tooth, with a dorsal seta on the head on each side of and adjacent to the posterior portion of the fronto-clypeal area ____ 15
    Nasale consisting of one single- or triple-pointed tooth; without dorsal setae adjacent to the posterior portion of the fronto-clypeal area ____ 11
11. Presternum of prothorax consisting of one large triangular sclerite ____ 12
    Presternum of prothorax divided into 2 or more sclerites (Fig. 34) ____ *Ctenicera*
12. Lateral margins of ninth abdominal segment with two or more prominent projections on each side; caudal notch variable ____ 13
    Lateral margins of ninth abdominal segment sinuate with not more than one prominent projection on each side (Fig. 36) caudal notch small ____ *Limonius*
13. Dorsum red-brown to black; urogomphi with outer prongs longer than inner ____ *Denticollis*
    Dorsum yellow-brown or amber; urogomphi variable *Ctenicera*
14. Eyes present; abdominal segments with conspicuous pits or crescent-shaped sculpturing ____ *Athous*
    Eyes absent; abdominal segments with crescent-shaped sculpturing (Fig. 35) ____ *Hemicrepidius*

15. Lateral margins of ninth abdominal segment with prominent projections, anterolateral impressions on tergites of abdominal segments 2 through 8 reaching or approaching mid-dorsal line ---------- *Ctenicera*
    Lateral margins of ninth abdominal segments smooth or hardly protuberant; anterolateral impressions absent or more abbreviated (Fig. 48) (Negastrini = Hypnoidini) ------- 16
16. Nasale consisting of one triple pointed tooth; urogomphi two pronged ---------- *Hypolithus*
    Nasale tridentate; urogomphi simple, undivided --- *Negastrius*
17. Sternum of ninth abdominal segment narrower anteriorly than sternum of eighth posteriorly (Fig. 40); tip of ninth segment broadly rounded (Elaterini) ---------- 18
    Sternum of ninth abdominal segment broader anteriorly than sternum of eighth posteriorly (Fig. 42); tip of ninth segment bluntly or sharply pointed or scalloped (Figs. 29, 41, 42, 44) ---------- 20
18. Nasale consisting of one triple-pointed tooth; second antennal segment with 5 or more papillae (Figs. 43, 45) ---------- 19
    Nasale consisting of one single-pointed tooth; second antennal segment with a single papilla ---------- *Sericus*
19. Second antennal segment with 8 to 13 papillae (Fig. 45) ---------- *Parallelostethus*
    Second antennal segment with 5 to 7 papillae (Fig. 43) *Elater*
20. Dorsum of ninth abdominal segment flattened and with margin scalloped (Fig. 29) (Melanotini) ---------- *Melanotus*
    Dorsum of ninth abdominal segment neither flattened nor scalloped ---------- 21
21. Nasale consisting of one triple-pointed tooth, abdominal tergites without striate impressions (Agriotini) ---------- 22
    Nasale variable, if consisting of one triple-pointed tooth, the abdominal tergites with striate impressions (Fig. 47) (Ampedini) ---------- 25
22. Ninth abdominal segment with a pair of central dorso-tergal setae (Fig. 41) ---------- *Dalopius*
    Ninth abdominal segment without central dorso-tergal setae (Fig. 44) ---------- 23
23. First 8 abdominal tergites with 3 or more prominent setae in a transverse line anteriorly (Fig. 46) (additional short setae may be present); eyes usually present ---------- 24
    First 8 abdominal tergites with only 2 prominent setae in a transverse line anteriorly (additional short setae may be present); eyes lacking ---------- *Agriotella*?

24. Submentum approximately 4 times as long as average width; most dorsal of the large anterior setae on the first 8 abdominal tergites with a small seta on either site transversely ---------- *Glyphonyx*
    Submentum not more than 3 times as long as average width; most dorsal of the large anterior setae on abdominal tergites without small setae on either side transversely (Fig. 44) ---------- *Agriotes*
25. Abdominal segments sparsely or finely punctured (Fig. 46) nasale tridentate ---------- *Megapenthes*
    Abdominal segments conspicuously sculptured or with pits or coarse punctures (Fig. 47) nasale usually consisting of one single-pointed tooth ---------- *Ampedus*
26. With an eye at base of each antenna (Fig. 32) -- *Cardiophorus*
    Without eyes ---------- *Horistonotus*

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SOME HELMINTH PARASITES FOUND IN TURTLES FROM NORTHEASTERN WISCONSIN

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Little information is available on the parasites of turtles from Wisconsin. During the course of work on *Heronimus chelydrae,* the turtle lung fluke (Guilford, 1958), there was also opportunity to examine 63 turtles for other helminth parasites. Of these turtles, 54 were painted turtles, *Chrysemys picta,* 6 were common snapping turtles, *Chelydra serpentina,* 2 were wood turtles, *Clemmys insculpta,* and one was a Blanding's turtle, *Emys blandingi.* Turtles were collected primarily from Chute Lake in Oconto County, and from High Falls Reservoir and the Peshtigo Flowage in Marinette County. The above flowages have uneven shorelines, large numbers of submerged logs, old stumps, a heavy growth of aquatic vegetation, and a variety of aquatic invertebrates. Other turtles were collected from river environments with comparatively less vegetation and animal life such as Duck Creek and the Fox River in Brown County, the Oconto River in Oconto County, the Menominee River in Marinette County, and the Sugar River in Door County. The one Blanding's turtle was collected in a field near Suamico in Oconto County. All turtles were collected in May, June, or early July.

Helminth identifications were made from living or fixed and stained specimens of trematodes, and temporary lactic acid mounts of nematodes. Mature specimens of 12 species of trematodes and 3 species of nematodes were found. No acanthocephala were found. Turtle leeches, though abundant, were not collected. Table I summarizes the identifications by listing hosts and the geographical location from which each came, and the parasites and the number of turtles infected with each species of helminth.

Most of the helminths listed on Table I are species of turtle parasites common in the eastern half of the United States. *Dictyangium chelydrae* Stunkard 1943, originally reported from *Chelydra serpentina* in Louisiana and thereafter in Ohio from the geographic terrapin, *Graptymes geographica* (Rausch. 1947) was collected in this survey from the cloaca of *Clemmys insculpta.* This is a new host record and extends the range of *D. chelydrae* into Northern Wisconsin. The specimen *Neopolystoma sp.* from a painted turtle from Door County, was found in the nostrils. This single specimen

TABLE I

Helminths Found in Turtles From Northeastern Wisconsin

Turtle Species	Location	Number Collected	Number Infected	Helminth Species	Number of Turtles Infected
Chrysemys picta	Chute Lake	22	21	*Allossostomoides parvum* (Stunkard, 1917)	3
				Camallanus microcephalus (Duj., 1845)	17
				Eustomos chelydrae (MacCallum, 1921)	4
				Heronimus chelydrae (MacCallum, 1902)	5
				Neopolystoma orbiculare (Stunkard, 1917)	2
				Protenes angustus (Stafford, 1900)	9
				Spirorchis sp. immature	2
				Nematoda sp. immature	1
	High Falls Reservoir	15	14	*Allossostomoides parvum*	3
				Camallanus microcephalus	11
				Eustomos chelydrae	3
				Heronimus chelydrae	7
				Neopolystoma orbiculare	1
				Spiroxys constricta (Leidy, 1856)	1
	Peshtigo Flowage	11	7	*Allossostomoides parvum*	1
				Camallanus microcephalus	4
				Eustomos chelydrae	3
				Heronimus chelydrae	5
				Neopolystoma orbiculare	1
				Spiroxys constricta	4
	Brown County	3	2	*Camallanus microcephalus*	1
				Protenes angustus	1
				Spirorchis elegans (Stunkard, 1923)	1
				Telorchis attenuatus (Goldberger, 1911)	1
	Oconto River	2	1	*Spiroxys constricta*	

Chrysemys picta—Continued	Sugar River	1	1	*Camallanus microcephalus*	
				Eustomos chelydrae	
				Neopolystoma orbiculare	
				Neopolystoma sp.	
				Protenes angustus	
				Spirorchis elegans	
Chelydra serpentina	Menominee River	1	1	*Auridistomum chelydrae* (Stafford, 1900)	
				Eustomos chelydrae	
				Hapalorhynchus gracilis (Stunkard, 1922)	
				Spironura affine (Leidy, 1856)	
				Spirorchis haematobium (Stunkard, 1922)	
				Spiroxys constricta	
				Telorchis corti (Stunkard, 1915)	
	Brown County	4	4	*Camallanus microcephalus*	3
				Spirorchis haematobium	1
				Spiroxys constricta	2
				Telorchis corti	1
	Peshtigo Flowage	1	1	*Telorchis* sp. immature	
Clemmys insculpta	Peshtigo Flowage	2	1	*Camallanus microcephalus*	
				Dictyangium chelydrae (Stunkard, 1943)	
				Telorchis corti	
Emys blandingi	Suamico	1	1	*Camallanus microcephalus*	
				Spiroxys constricta	
				Telorchis corti	
				Nematoda, immature	

can not be assigned to present species included in this genus because it is not fully mature so organ proportions differ from known species, and also because it possesses fewer genital hooks (8) than other species. Fully mature specimens of this form are necessary before a determination can be made.

Though the numbers of turtles and helminths collected were too small to make any conclusions as to the geographical habitats of the parasites, it was noted that the nematodes *Camallanus microcephalus* found in 62% of the hosts and *Spiroxys constricta* from 16% were distributed over the entire area surveyed, while the trematodes *Heronimus chelydrae* from 27% and *Allossostomoides parvum* in 11% of the hosts were found only in flowages.

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FLEAS COLLECTED FROM COTTONTAIL RABBITS IN WISCONSIN[1]

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This study primarily concerns two species of fleas collected from the Mearns cottontail rabbit, *Sylvilagus floridanus mearnsii* (Allen), in Wisconsin. Notes are given on the morphology and bionomics of *Cediopsylla simplex* (Baker), and on the bionomics of *Odontopsyllus multispinosus* (Baker). Nine species of fleas which commonly infest other mammals were also collected from the cottontails.

METHODS

Most of the rabbits were live-trapped from May 1955 through November 1956 and shot from December 1955 through February 1956 in the University of Wisconsin Arboretum, Dane County, Wisconsin. Twenty-eight were shot in other parts of the state from March 1956 through August 1956. Rabbits obtained from late November 1955 through early March 1956 were killed and placed in plastic bags before the fleas were collected. All other live-trapped rabbits were first confined to a cloth bag while the fleas were removed from the bag and rabbits. The rabbits were then tatooed and released at the trap site. Fleas were also collected from cottontail nests.

All stages of *C. simplex* were confined in 21 x 70 mm. vials capped with cheesecloth and reared at 92–93% R.H. and 24–28° C.

RESULTS AND DISCUSSION

Descriptions

Egg—Based on a single specimen, the egg of *C. simplex* is faintly sculptured, shiny, subcylindrical in the middle, and with rounded ends. It is pearly white at oviposition and measured 0.29 by 0.47 mm.

Larvae—Since those collected were not identified, they are not described.

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[1] Based on part of a thesis submitted by the senior author to the University of Wisconsin in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Approved for publication by the Director of the Wisconsin Agricultural Experiment Station. Journal Paper No. 43, University of Wisconsin Arboretum Series.

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Cocoon—The cocoons of *C. simplex* are brittle, light brown, shiny, subcylindrical in the middle and with rounded ends. Debris frequently adheres to the surface. Average measurements were 1.0 by 2.5 mm.

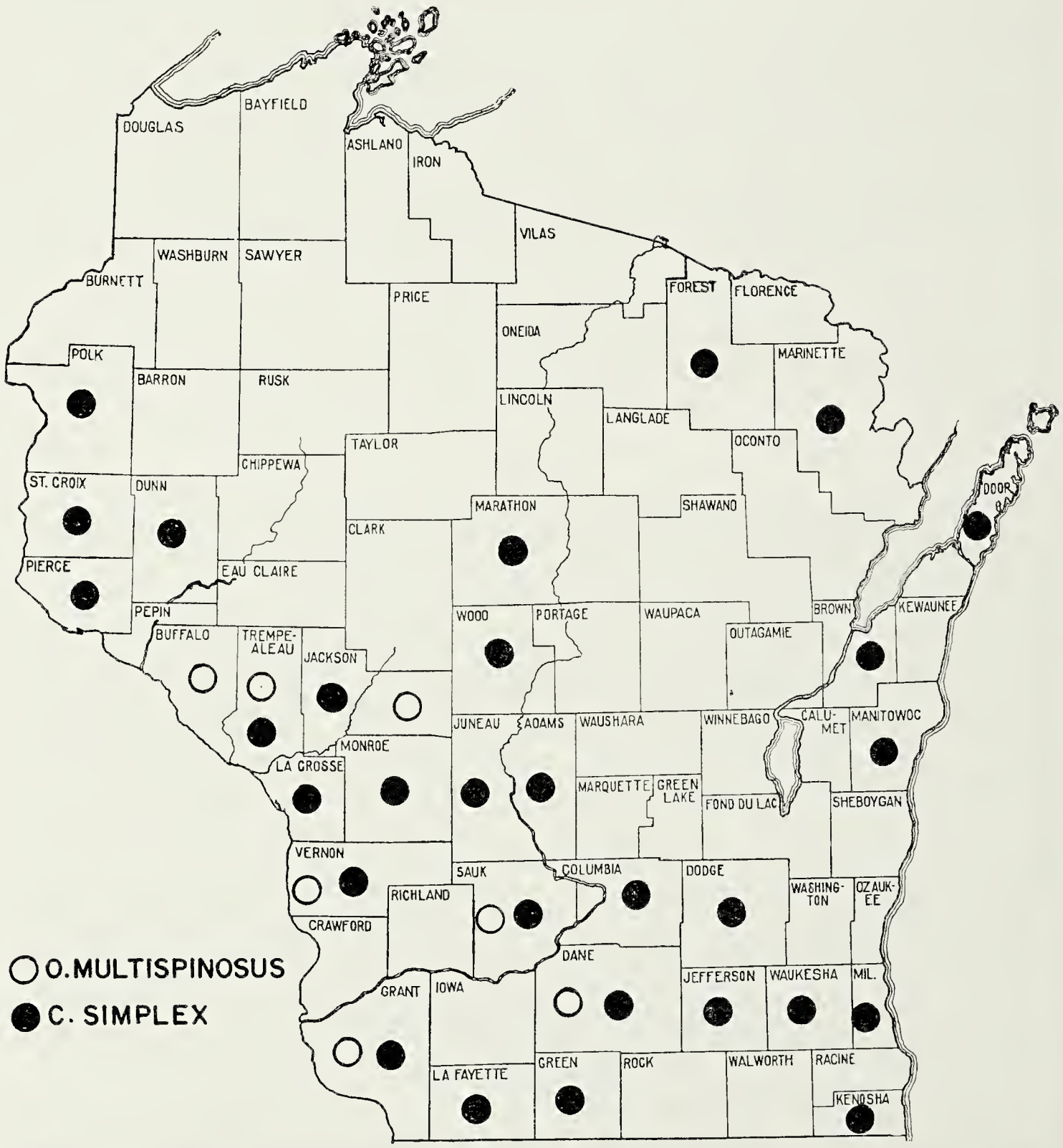

FIGURE 1. County records of the rabbit fleas *Cediopsylla simplex* (Baker) and *Odontopsyllus multispinosus* (Baker) in Wisconsin.

Adult—Baker (1904) stated that each species had a ". . . very constant . . ." number of spines in the genal ctenidium. He recorded eight spines in the *C. simplex* male. Among the nearly 25,000 specimens from Wisconsin, the usual number of spines was eight, but a few specimens of both sexes had six, and one female was noted with 10 on one side.

Biology and Ecology

Geographical distribution—The cottontail inhabits all counties of Wisconsin (Wisconsin Conservation Department, 1935–1955), but no animals were collected north of Polk and Forest Counties in this study. Range limits of the two eastern rabbit fleas may exist in Wisconsin. Known locality records, many of which are new, are shown in Figure 1.

TABLE I

COLLECTIONS OF *C. simplex* (BAKER), ON UNMARKED COTTONTAILS, UNIVERSITY OF WISCONSIN ARBORETUM, MAY 1955 TO NOVEMBER 1956

Month	Fleas			Number of Cottontails	
	Number per host			Examined	Infested
	Mean	Median	Range		
May	2	1	1– 4	8	4
June	7	4	1– 28	18	17
July	17	11	1– 63	42	36
Aug.	10	7	1– 45	81	75
Sept.	8	5	1– 28	93	85
Oct.	16	11	1–164	71	70
Nov.	23	16	2– 75	28	28
Dec.	14	12	1– 45	102	101
Jan.	11	10	1– 37	110	107
Feb.	13	10	1– 51	111	108
March	15	8	1– 84	19	19
April	18	14	1– 46	21	19
May	21	11	1– 86	20	16
June	8	5	2– 13	7	4
July	15	6	3– 33	6	6
Aug.	15	9	1– 88	42	40
Sept.	24	17	1–114	62	60
Oct.	30	23	1–127	159	158
Nov.	43	34	2–196	105	105
Total	19	12	1–196	1,105	1,058

Seasonal incidence—The flea population data are based on samples of hosts from two aging populations. The first population began in May 1955 with juveniles and ended in May 1956 with adults, most of which were born in 1955. The second population existed from June 1956 through November 1956 and was composed of juveniles.

C. simplex was the more abundant rabbit flea. It infested cottontails throughout the year. Monthly population data on unmarked cottontails in the Arboretum are presented in Table I. Although flea incidence data are usually expressed in mean numbers per host (infested animal), the median numbers were also calculated, be-

cause, in spite of their underestimation of the true population, they were considered to be more representative by equalizing the extremely high values with a lower more typical value.

Uninfested, unmarked cottontails were included in the t-test analyses of *C. simplex* populations. As the distribution of the flea was extremely skewed, shown partly by the relatively lower median numbers, less weight was given to the high X-values by transformation of data to the square root of X + 0.5.

TABLE II

COLLECTIONS OF *O. multispinosus* (BAKER), ON UNMARKED COTTONTAILS, UNIVERSITY OF WISCONSIN ARBORETUM, MAY 1955 THROUGH NOVEMRER 1956

MONTH	FLEAS		NUMBER OF COTTONTAILS	
	Mean Number per Host	Range	Examined	Infested
May	0	.....	8	0
June	0	.....	18	0
July	0	.....	42	0
Aug.	0	.....	81	0
Sept.	3	1– 9	93	5
Oct.	2	1– 4	71	6
Nov.	1	1– 3	28	5
Dec.	2	1– 4	102	19
Jan.	2	1– 4	110	8
Feb.	2	1– 7	111	33
March	0	.....	19	0
April	1	1	21	1
May	1	1	20	1
June	0	.....	7	0
July	0	.....	6	0
Aug.	0	.....	42	0
Sept.	2	2	62	1
Oct.	2	1– 9	159	30
Nov.	4	1–17	105	53
Total	3	1–17	1,105	162

The seasonal incidence in 1956 differed from that in 1955 in three ways: 1) the autumn population increase significant at the 1% level occurred between October and November rather than between September and October, 2) the July through September decline did not recur, and 3) in 1956 the populations of September, October and November were significantly higher at the 1% level.

O. multispinosus could not be found on cottontails in the Arboretum during March, June, July and August (Table II). Had more rabbits been trapped, the flea probably would have been detected in

March and June. It was collected in three west-central counties on June 19, and a specimen was collected in June in Iowa by Joyce and Eddy (1944). The latest arboretum record was May 3 and the earliest September 1.

Sex ratio—C. simplex females infested 1,026 unmarked arboretum cottontails with a mean of 12 per host, a median of 8, and a range of 1–132. For the males the respective data were 975, 8, 5 and 1–68. The differences are manifestations of the sex ratio, which was 66 males per 100 females (8,055 males: 12,172 females). Stannard and Pietsch (1958) reported a ratio of 56:100 in northern Illinois. By contrast, a study of a single Wisconsin cottontail nest in August 1956 yielded 280 male and 254 female pupae and teneral adults.

If months in which a 2-year total of over 1,000 *C. simplex* were collected are analyzed according to the number of males per 100 females, the trend was up in the fall and down in the winter as follows: 63, 68, 71, 61, 58 and 52, September through February, respectively. The later emergence of males is perhaps partly responsible for the apparent delay in host acquisition by males until October and November.

On the unmarked cottontails in the arboretum, the mean of both male and female of *O. multispinosus* was 2 per host and a range of 1–11, but only 98 hosts carried the male in contrast with 122 that carried the female. Totals of 187 males and 267 females were collected for a male to female ratio of 70:100.

Behavior on host—Unlike the published observations by Stannard and Pietsch (1958), the two fleas were environmentally separated on the host. *C. simplex* infested the head, especially its top, and fed on the tips and in the inner folds of the ears, and around the eyes. Haugen (1942) noted that during the winter each inner fold frequently had a row of fleas feeding and causing hemorrhages. Probing the fleas that had their mouth parts inserted usually failed to cause their withdrawal. In fact, dead hosts were found with dead *C. simplex* adults attached by their mouth parts to the inner folds. This flea was otherwise easily disturbed. Blowing into the pelage stimulated many individuals to leap from the host, but on landing they occasionally feigned death.

O. multispinosus, infested the back and sides of the cottontails. It was difficult to stimulate by pelage blowing. Compared with the smaller *C. simplex* this flea made fewer and shorter jumps but ran more swiftly.

Breeding and development—Most of the female *C. simplex* on adult hosts in the spring were gravid. A flea collected in November 1955 oviposited one egg in the laboratory. Eggs of an unidentified

species were collected singly from the pelage of a heavily infested lactating host caged in the laboratory in April 1955 and in clusters of less than 14 from a cottontail nest in April 1956.

The heat of nest rabbits may be available to eggs and larvae during most of a 16-day period (Ecke, 1955). *C. simplex* larvae were concentrated in the moist organic matter on the bottom of the nest where the grass and fur linings meet. There they spun cocoons and pupated. Beginning in mid-April, a cottontail in southern Wiscon-

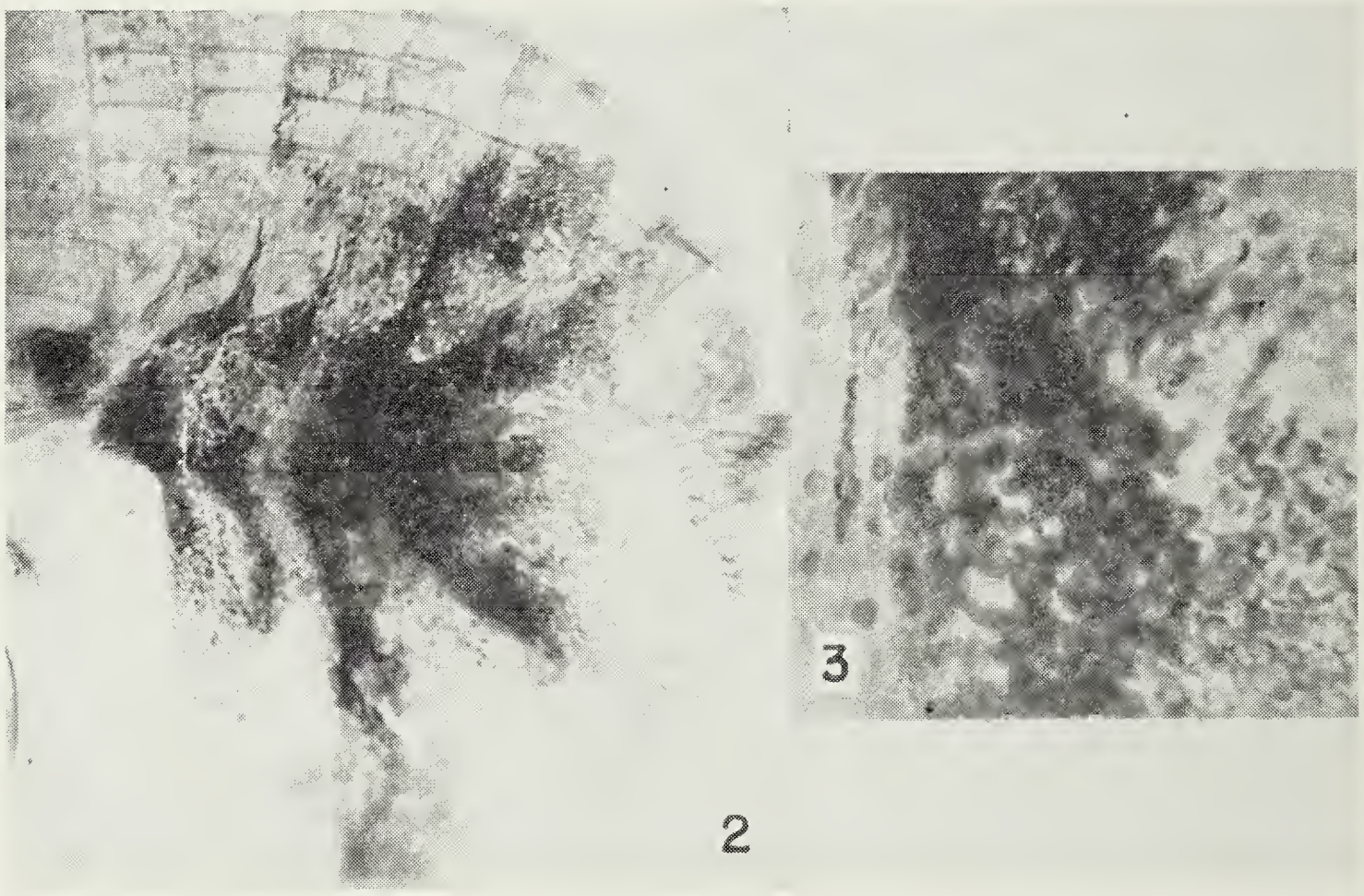

FIGURE 2. Part of the abdomen of a female *Cediopsylla simplex* (Baker) adult cleared to exhibit the arrangement of fungus spores (x72).

FIGURE 3. Enlargement of the specimen in Figure 2, showing fungus spores on the conjunctiva beneath the flange of sternum V (x240).

sin may have three or more litters per season. Each nest is a potential breeding site and dispersal focus for hundreds of fleas. A total of 564 immature fleas was found in a nest collected in August 1956.

C. simplex pupae were collected in Madison on August 7 from a cottontail nest about 22 days old. Pupation was evidently recent, since pigmentation was scant. In the laboratory the first adult, a female, emerged on August 8. Three more females emerged on August 11. The males did not begin emergence until the 12th. Maximum emergence was on August 13 by females and on the 14th and 15th by males. Thus, at room temperatures the mean pupal periods for females and males are not less than 6 and 7.5 days, respectively. Lesson (1932) reported that *Xenopyslla cheopis* (Rothschild)

females emerge sooner than males. Ewing and Fox (1943) isolated a *C. simplex* larva in a vial on April 11 and obtained an adult on April 29. Apparently that larva did not spin a cocoon. All pupae collected from the cottontail nest in this study were within cocoons.

Disease—A *C. simplex* adult female collected in the arboretum in October 1956 was observed with a peculiar black area in the abdomen from which minute, (at x13) brown, oval, objects could be forced. Disease was suspected from this observation. Steinhaus (1949) reported that fleas appeared to be parasitized by an unidentified fungus and that culturing might be required for identification. His efforts, however, to germinate spores and to cultivate the fungus on carbohydrate media, including Sabourand's agar, were not successful.

The spores, approximately 7.5 by 8.3 mμ, were usually concentrated on the conjunctivae beneath the flanges of the terga and sterna on one side of the abdomen (Figure 2). Occasionally only the sterna were affected. In dorsal aspect the abdomen of those fleas with enormous numbers of spores on one side usually was curved with the spores on the convex side. The flanges were frequently forced noticeably outward. The spores appeared more or less oval and saucerlike (Figure 3) after clearing in ethenol. At x430 they appeared to have a blackish spore wall but were colorless within. They were readily seen beneath the flanges after clearing in 10% KOH for nine hours. Discoloration and change in body shape are considered by Steinhaus (1949) as common symptoms in diseased insects.

In a peak population of *C. simplex* on unmarked arboretum cottontails in November 1956, 2.43% of the 1,896 male fleas and 2.53% of the 2,643 females were considered diseased. On the 105 hosts of *C. simplex,* diseased fleas were distributed as follows: 11 carried only the male, 20 only the female and 15 both sexes. More fleas were probably diseased but these were not detected either because the infections were mild or because the sporulation stage had not been reached. Although *O. multispinosus* attained a peak population the same month, it did not exhibit disease symptoms.

Other mammal fleas collected—The following nine additional species of mammal fleas were collected from cottontails in the arboretum:

Ctenocephalides felis felis (Bouche), *Epitedia wenmanni wenmanni* (Rothschild), *Megabothris asio megacolpus* (Jordan), *Monopsyllus wagneri systaltus* (Jordan), *Nosopsyllus fasciatus* (Bosc.) *Opisocrostis bruneri* (Baker), *Orchopeas howardii howardii* (Baker), *Orchopeas leucopus* (Baker) and *Thrassis bacchi bacchi* (Rothschild).

Madison apparently lies in the zone of intergradation of *M. a. megacolpus* and *Megabothris asio asio* (Baker). The two females collected appear to be the first subspecies, but the male is very close to *M. a. asio*.

Summary

Descriptive notes are given for the egg, cocoon and adult of *Cediopsylla simplex* (Baker). Many new locality records for *C. simplex* and *Odontopsyllus multispinosus* (Baker) were obtained in Wisconsin. The seasonal incidence of these rabbit fleas were determined from May 1955 through November 1956 from collections of 1,105 cottontail rabbits, *Sylvilagus floridanus mearnsii* (Allen), in the University of Wisconsin Arboretum. Both fleas attained peak populations in November 1956, but *C. simplex* was always more abundant. In the larger samples, females outnumbered males. *C. simplex* infested the head of the host, while *O. multispinosus* infested the back and sides. *C. simplex* larvae spun cocoons and pupated in a cottontail nest. Among the pupae and teneral adults collected from the nest there were slightly more males than females, but the period of maximum emergence of females preceded that of males by only about 36 hours. A possible fungus disease of *C. simplex* adults was detected. The following nine species of fleas which are common on other mammals were also collected from cottontails:

Ctenocephalides felis felis (Bouche), *Epitedia wenmanni wenmanni* (Rothschild), *Megabothris asio megacolpus* (Jordan), *Monopsyllus wagneri systaltus* (Jordan), *Nosopsyllus fasciatus* (Bosc.) *Opisocrostis bruneri* (Baker), *Orchopeas howardii howardii* (Baker), *Orchopeas leucopus* (Baker) and *Thrassis bacchi bacchi* (Rothschild).

Acknowledgments

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The authors are indebted to all persons who aided, especially Dr. R. A. McCabe, Dr. R. S. Ellarson and Mr. J. R. Jacobson who provided many of the cottontails and certain information and equipment necessary for trapping and hunting. Dr. E. A. Steinhaus diagnosed the apparent fungus disease of *C. simplex*, and assisted in its study.

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GROWING CORN IN WISCONSIN WITHOUT PLOWING[1]

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Planting corn without plowing may permit farmers to produce this row crop under soil improving rather than soil depleting conditions. Corn has long been accused of being a soil robber and an invitation to soil erosion. However since the moleboard plow was invented more than 100 years ago, little effort has been made to produce corn without plowing. In 1952 Scarseth (4) reported that the trouble in producing corn is the method by which corn is being produced rather than the crop itself and that adequate fertilizing, properly timed and placed, may be the factor which can give sound cash profit foundation to "mulch corn tillage" and thereby result in a considerable improvement in soil and water conservation. With the development of the mulch planter an entirely new approach was possible to the corn production problems. Hulbert and Wittmuss (3) indicated that combining tilling and planting into one operation saves not only labor, but helps reduce water and wind erosion and tends to reduce weed growth. Even though Borst and Mederski (1) agreed that mulching reduces erosion, they indicated that mulch tillage is much more of an art than is conventional plowing and therefore may be extremely difficult to do a good job.

Methods

Experimental trials were established comparing the conventional seedbed preparation and the mulch planting method on three major Wisconsin soil types: (I) Miami silt loam on the University Farms, Madison, (II) Spencer silt loam, near Marshfield, and (III) Fayette silt loam near Prairie du Chien. The conventional seedbed preparation, consisting of spring plowing, two discings and one or two harrowings prior to planting, was compared with the once over operation of the mulch planter. The mulch planter is a combination implement in which a regular corn planter is mounted on the back of a tractor and two 3-foot sweeps that peel back the soil to a depth of 3 inches are mounted on the tractor cultivator frame behind the front tractor wheels. This leaves about 4 inches of undisturbed soil between the sweeps. A second (18-inch) sweep is located 4 to 6

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[1] Published with the approval of the Director, Wisconsin Agricultural Experiment Station.

[2] Associate Professor and Professor of Soils, respectively.

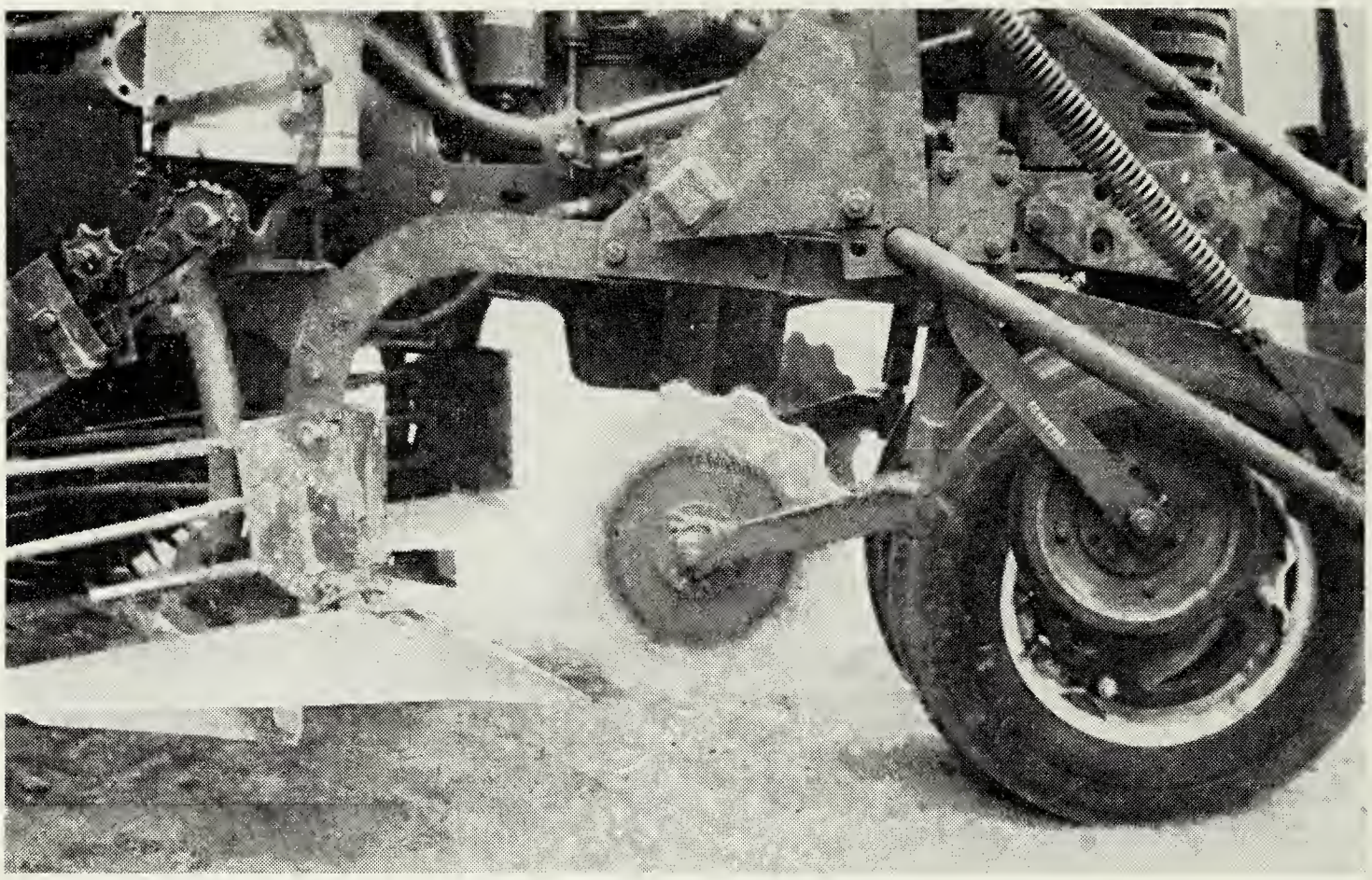

FIGURE 1. Side view of the mulch planter showing location of large and small sweeps that open furrow in the soil and place deep fertilizer application.

FIGURE 2. Rear view of mulch planter showing alignment of corn planter with the furrow made by the front sweeps.

inches below (depending on setting) each 3 foot sweep and penetrates to a depth of 7 to 9 inches. The lower sweep places the deep fertilizer band and prepares the seedbed for the planting of the corn as shown in Figure 1. The corn planter unit, pulled directly behind the tractor, places the seed in the furrows left by the sweeps (Figure 2).

Adequate plant food applications were made, which consisted of broadcast applications of approximately 800 pounds of 10–10–10 per acre plowed down for the conventional corn planting treatment or 800 pounds per acre of 10–10–10 placed 9 inches deep for the mulch planter treatment. Three hundred pounds of 4–16–16 or 5–20–20 per acre of starter fertilizer were also drilled near the corn row. The mulch-planted corn was usually cultivated once, while the conventional plantings were usually cultivated 2 or 3 times. All of the corn was sidedressed with 250 to 300 pounds per acre of ammonium nitrate when it was approximately knee high or at the time of last cultivation. The treatments were only duplicated at each location since the size of the equipment made it impossible to have more replicates.

Results and Discussion

The yield of corn and the plant population for the mulch and conventional planted corn for the four year period is given in Table 1.

These yields indicate that in the better corn growing areas of the state, namely the Miami and the Fayette soil type, approximately equal yields were obtained with either the conventional or the mulch planting method when the plant populations were about the same. The 15 bushel greater yield with conventional planting on Fayette soil in 1954 is believed due to the greater plant population. It is doubtful if the yield differences in other years were significant.

It is of interest to note here that rodent and pheasant damage was much more serious with mulch planting than with the conventional seedbed preparation. In some cases the corn had to be partially replanted two or three times by hand in order to obtain a satisfactory stand with the mulch planting.

The comparatively low corn yield from the Spencer soil is due to the relatively short growing season in the northern part of the state. This soil has poor internal drainage and usually remains cold and wet into early summer. Permitting vegetation to grow up until corn planting time would seem to be an excellent method to help dry and warm the soil in the spring and should result in earlier planting date, better seed germination, and improved corn yields. However, the 1953 and 1954 growing seasons were unusually wet in this area and the corn yields were somewhat below the 65 bushel

long time average grain yield for the Marshfield Branch Experiment Station. The seven bushel average increase in yield from conventional planting is largely due to the higher plant population.

TABLE I

SOIL TYPE, POPULATION AND YIELD OF CORN ON MULCH AND CONVENTIONAL PREPARED SEEDBED EXPERIMENT, 1952–1955

SOIL TYPE (SILT LOAM)	METHOD OF PLANTING	WISCONSIN HYBRID	POPULATION PLANTS/A	YIELD BU./A*
	1952			
Miami	Mulch	641AA	15,920	135
Miami	Conv.	641AA	15,400	131
	1953			
Miami	Mulch	641AA	16,300	121
Miami	Conv.	641AA	16,960	123
Spencer	Mulch	240	13,300	48
Spencer	Mulch	335	13,960	49
Spencer	Conv.	240	14,700	62
Spencer	Conv.	335	14,100	52
Fayette	Mulch	641AA	19,140	114
Fayette	Conv.	641AA	21,400	123
	1954			
Spencer	Mulch	240	12,940	46
Spencer	Mulch	335	13,600	49
Spencer	Conv.	240	14,120	50
Spencer	Conv.	335	14,910	64
Fayette	Mulch	641AA	13,590	120
Fayette	Conv.	641AA	16,150	135
	1955			
Fayette	Mulch	641AA	15,810	79
Fayette	Conv.	641AA	15,170	85

*Average yield of duplicate plots.

Since two corn planters were used in this study—one mounted on the till planter tractor, and the other planter used by the Branch Experiment Stations for the conventional corn planting, it was impossible to obtain the same plant population. However, in another study (2) it was found that when the sweeps were dropped off of the mulch planter unit and the same planter was used for both conventional and mulch planting, the plant population averaged 4,000 more per acre on the mulch planted plots. This was significant at the 5% level. The better stand on the mulch planted corn is believed due to less structure damage and hence better aeration and possibly less surface crusting.

The power requirements for pulling the mulch planter varied greatly depending on the vegetative cover of the field, the moisture content of the soil, and particularly the depth of penetration of the bottom sweep. If there had been appreciable erosion so that the bottom sweep penetrated the subsoil (B horizon) the power requirements increased substantially. It was necessary to add additional wheel weights and fluid in the tractor tires to provide sufficient traction. If planting is in old sod it appears desirable to put tire chains on the tractor, and disc twice before planting in order to give the sweeps a better chance to penetrate the soil. It was unnecessary to disc grain stubble or corn stalks unless the material was so long that it clogged the mulch planter. Mulch planting would not be suitable for stoney land since the bottom sweeps would be damaged.

When planting on contour slopes greater than 8 percent, it was difficult to adjust the sweeps to cut at a uniform depth for traveling in both directions. Also, when chains were not used on steep slopes wheel slippage caused the tractor to turn at a slight angle to the direction of planting and threw the planter out of alignment with the prepared furrows.

With mulch planting the weed problem increased during the second and third year of continuous corn. The grassy and tall broadleaf annual weeds were a much greater problem than quackgrass. Therefore, with continuous mulch planted corn chemical weed control would appear to be necessary. A regular show type cultivator was used without difficulty.

The effect of mulch planting on reducing erosion and water loss during the summer growing season was spectacular. In one storm recorded on June 2, 1954, a two inch downpour two days after planting resulted in a loss of 1.75 inches of water from the conventional planting as well as 10.3 tons of soil per acre. However, where the corn had been mulch planted no appreciable soil or water was lost. In a year when such rains occur the saving in water by mulch planting could well make the difference between a good or poor crop if dry weather should follow.

Summary

A four year study was made to determine if corn can be grown successfully in Wisconsin without previous plowing. Comparisons were made of corn planted with conventional method and corn planted with a special mulch planter. With average weather conditions and use of an adapted hybrid, excellent yields were obtained for both methods.

The results indicate that to mulch plant successfully one must: (a) provide adequate plant food for both corn and weeds, (b) fol-

low normal good corn cultural practices, (c) make sure that a tractor with the necessary power (3 plow or more) is available and (d) carefully adjust the depth of the sweeps (this is especially important on sloping land). Soil and water losses from mulch planted fields having slopes up to 10 percent were negligible even with intense rains of two inches per hour, whereas, with conventional planting, losses of ten tons of soil and 1.75 inches of water per acre occurred.

Although the difficulties encountered in satisfactorily planting corn with the mulch planter make it relatively impractical on the average Wisconsin farm, this study clearly demonstrated the potentials of new soil tillage methods for growing corn. Many of the advantages of mulch planting have recently been incorporated into a promising new and simplified minimum soil tillage method called "Wheel track corn planting". (5)

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ARTS AND LETTERS

THE CONCEPT OF THE JUDGE-PENITENT OF ALBERT CAMUS*

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In awarding the Nobel Prize for Literature, 1957 to Albert Camus, the Swedish Academy honored him in the words of Dr. Anders Osterling ". . . for his important literary production, which with clear-sighted earnestness illuminates the problems of the human conscience in our time."[1] Throughout his work Camus has sought to redefine moral values in terms acceptable to a world which by its actions has denied the validity of former sources of morality and truth. In *Combat* he wrote, September, 1945, ". . . it is a matter of finding out for ourselves whether man, without help of religion or of rationalist thought, can solely by himself create his own values."[2] In accepting the Nobel Prize in Stockholm on December 10, 1957, Camus elaborated this definition of the problem confronting his contemporaries. He declared, "As the heir of a corrupt history that blends blighted revolutions, misguided techniques, dead gods, and worn out ideologies, in which second-rate powers can destroy everything today, but are unable to win anyone over, in which intelligence has stooped to becoming the servant of hatred and oppression, that generation, starting from nothing but its own negations, has had to re-establish both within and without itself a little of what constitutes the dignity of life and death."[3]

For Camus, total negation is the first step toward facing the problem of life and its meaning. Without this negation, which in its totality also includes that of one's self as an identity, one remains under the deceptive intellectual traditions of the past which assume that the order of the universe is identical with that of human reason. The incompatibility between man's desire for clear and complete explanations in his own terms and the inability of an irrational world to yield them produces the absurd. In "The Myth of Sisyphus" Camus wrote, "This world in itself is not rational, that is all one can say about it. But what is absurd is the confrontation

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* Paper read at the 89th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

[1] Albert Camus, "Speech of Acceptance upon the Award of the Nobel Prize for Literature, December 10, 1957" (New York, Knopf, 1958), p. v. Quoted from the citation read by Dr. Anders Osterling, permanent secretary of the Swedish Academay.

[2] Albert Camus, "Actuelles I" (Paris, Gallimard, 1950). The quotation is reprinted on page 111.

[3] Albert Camus, "Speech of Acceptance upon the Award of the Nobel Prize for Literature, December 10, 1957" (New York, Knopf, 1958), p. xi.

of this irrationality and of this desperate desire for clarity whose cry resounds in the innermost depths of man. The absurd depends as much on man as on the world. It is, for the time being, their only bond."[4] The fundamental manifestations of the absurd is man's aspiration for the eternal and his subordination to duration and death.

Camus finds the meaning of life then can only reside in confronting the absurd and in revolt against it, not in turning away from it. "Now one will not live out this destiny, knowing it to be absurd, unless one does everything possible to keep before oneself this absurdity brought to light by the consciousness of it. To deny one of the terms of this antithesis by which the absurdity lives is to escape from it. To abolish conscious revolt is to evade the problem. The theme of permanent revolt is thus carried into individual experience. To live is to make the absurd live. Making it live is above all looking at it. Unlike Eurydice, the absurd dies only when one turns away from it."[5]

For this reason suicide is inadmissible, since it is a conscious avoidance of the total problem. God and other absolutes nullify the contradictions of life by substituting a further inexplicable element. Camus refuses to accept what is beyond his understanding. Since the absurdity of the world is a cruel and hostile force, any subjection to irrationality of any type is an humiliation of the intellect. "I want to know whether I can live with what I know and with that alone. I am still told that intelligence must sacrifice its pride and that reason must humble itself. But if I recognize the limits of reason, I do not deny it by doing so, recognizing its relative powers. I only want to pursue a steady course in this middle road where intelligence can remain clear. If that is its pride, I do not see sufficient reason for giving it up."[6]

Camus, therefore, remains firmly on the plane of the intellect; and since he cannot get from the world an explanation of the absurdity, he rebels against this humiliation and sets against it his philosophy of revolt, which originates in a primitive feeling of human solidarity and human dignity. This revolt protests against absurdity, cruelty, and injustice and creates a moral value based on suffering. It demands as much liberty as is consistent with the liberty of one's neighbor. Any attempt to again revert to absolute standards, even of liberty, again produces the absurd in the form of a dictatorship. The rebel must always be prepared to answer the question of how he will deal with the man who opposes him. We have, therefore, the two basic elements of Camus' philosophy; the confrontation or recognition of the absurd and the revolt against it.

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[4] Albert Camus, "Le Mythe de Sisyphe" (Paris, Gallimard, 1942), p. 37.
[5] Ibid., p. 76.
[6] Ibid., p. 60.

Since Camus has made the absence of values the philosophical center of his work, he cannot accept the absolute moral values of traditional humanism. He is concerned with a restatement of moral values which can be contained within the limits of man's reason. These moral values must necessarily rise from suffering, since the absurdity of the world is cruel and hostile. Since all men are confronted with the same hostility and cruelty, they are bound to each other in a dual bond; they are the cause of their own suffering; and, through solidarity, the cause of their own moral judgments. But to achieve that solidarity through recognition of guilt and acceptance of penance, man must first examine his conscience.

This examination of conscience is the motivating force of *The Fall.* The concept of the *judge-penitent* is a facet of this examination of conscience.

In reading this *récit* of Camus, we find that he is interpreting Judeo-Christian concepts in contemporary tones. In this sense, this work becomes highly symbolical, and we must recognize ideals of the New Testament enveloped in the cloak of the liberal humanism of Camus.

In three of Christ's parables presented as an integral unit of the fifteenth chapter of Saint Luke, that of the lost sheep, the prodigal son, and the lost coin, the lesson is clearly drawn that man must lose himself before he can enter the Kingdom of Heaven, that he must deny his own nature of self-interest to find himself again as a living testimony of the love of God and the love of neighbor. The first Christian symbol of this "losing of self" was John the Baptist, a voice crying in the wilderness. John had the opportunities of birth, as the son of a priest, which would have insured him a substantial and respected place in life. He chose, however, to retire to the wilderness and, in a state of abject humility, to call man to a life of repentance, in other words, to an examination of the real value of the individual in defining the meaning of life. The two concepts of penance, which is a form of suffering, and of judgment embodied in John the Baptist are the foundation of *The Fall* and its cultural theme of the judge-penitent.

The Fall is a monologue of self-accusation by the character Jean-Baptiste Clamence to a chance acquaintance encountered in the *Mexico City Bar* in Amsterdam. The symbolism of the first name Jean-Baptiste, John the Baptist, is readily apparent. The invention of the last name on the root of the Latin verb *clamare* (to call or to cry out) reenforces the conviction that Camus was intent on reinterpreting the Christian Biblical missionary. Clamence is also a bachelor with no emotional ties binding him to anyone. The Biblical wilderness was the physical means of divesting man of his material ties. In the same manner, the *Mexico City Bar* in Amsterdam is the symbol of the divorce from materialism. Those who frequent this

bar "come from the four corners of Europe and stop facing the inner sea, on the drab strand. They listen to the foghorns, vainly try to make out the silhouettes of boats in the fog, then turn back over the canals and go home through the rain. Chilled to the bone, they come and ask in all languages for gin at *Mexico City*."[7] "Fortunately there is gin, the sole glimmer of light in this darkness."[8]

Clamence is a former Parisian lawyer who had risen to a great success in his profession by mastering the art of parading self-interest as virtue. He had by studied effort brought himself to a perfect state of harmony with life. Being on the summits, on the right side of the law, self-indulgent, though esteemed by all, Clamence considered himself above judgment. This was the absolute value to which he attached himself, one to which he believed himself designated and for which he was peculiarly favored. Contented with his virtues, Clamence did not concern himself with the idea that he could be judged by others. He completes the summation of his character in these words, "I admitted only superiorities in me and this explained my good will and serenity. When I was concerned with others, I was so out of pure condescension, in utter freedom, and all credit went to me: my self-esteem would go up a degree."[9]

Though Clamence felt himself free, he did not realize that freedom demanded responsibility and that the exercise of freedom involves the judgment of each action evolving from it. While crossing the Pont Royal one night, he passed behind a feminine figure leaning on the railing and staring at the river. After he had crossed the bridge, he heard the sound of a body striking the water and later a cry, repeated several times, which was going downstream; then it suddenly ceased. In this instant Clamence was confronted with the need of making a decision, to save the woman or do nothing. This decision was forced upon him from without the framework of his personality and his virtue. He chose to do nothing. However, this inaction was an exercise of his freedom and the consequent fate of the woman, whether she lived or died, emanated from this exercise of freedom. Even such an excuse as "too late" or "too far" did not relieve him of responsibility in the life of this woman.

But Clamence was aware of the change in his life. He was now subject to judgment. As a result of this incident, he found himself insecure and questioning himself and his virtue. He had discovered the fact that freedom and responsibility were not separable. He had fallen from his summit, and his fall was this discovery of the responsibility of freedom.

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[7] Albert Camus, "La Chute" (Paris, Gallimard, 1956). "The Fall", translated by Justin O'Brien (New York, Knopf, 1956), p 15. All following citations are from this translation.

[8] Ibid., p. 12.

[9] Ibid., p. 48.

The further realization of Clamence was that the exercise of this responsibility was being judged by others. This realization is symbolized by his sensitivity to laughter which he heard on the dark foggy streets of Paris at night. Finally when in an altercation with a motorcyclist, he is struck and does not retaliate, he realizes that he is no longer the physical master of his well being. These episodes led him to distrust his physical and spiritual contentment. This distrust was in itself an act of judgment which awakened in him the realization that no one is innocent and that he too was being judged or accused and, therefore, was on the side of the guilty. This realization of lack of innocence, this change of status and the full awareness of its implications, is also part of the fall of Adam. In the Garden of Eden, Adam also learned that the exercise of a free choice carried with it inescapable responsibility which placed him among the guilty also. But just as Adam attempted to disclaim responsibility by turning to Eve, so Clamence attempted to find freedom without responsibility in debauchery or giving himself entirely into the power of his senses.

". . . true debauchery," he comments, "is liberating because it creates no obligations. In it you possess only yourself; hence it remains the favorite pastime of the great lovers of their own person. It is a jungle without past or future, without any promise above all, nor any immediate penalty. The places where it is practiced are separated from the world. On entering, one leaves behind fear and hope."[10] But again the world crowded in on him, and the image of the woman drowning in the Seine came back. And so Clamence had to come to terms with his "little-ease", "malconfort". Camus takes the instrument of torture of the Middle Ages, the cell in which a man could neither stand nor lie down, as the restriction which encompasses man and makes him realize guilt.

"Moreover, we cannot assert the innocence of anyone, whereas we can state with certainty the guilt of all. Every man testifies to the crime of all the others—that is my faith and my hope. . . . God is not needed to create guilt or to punish. Our fellow men suffice, aided by ourselves."[11]

The bond of guilt which the fall of Adam established for all mankind is the identical one which the responsibility of freedom has forged. Even the innocence of Christ in the eyes of Camus is compromised by the "Slaughter of the Innocents", for which He was in a measure responsible, when his parents sought refuge for Him in Egypt. So too the concept of the "just judge" is a fraud. For Camus the judge sits above the guilty not the innocent. He portrays this idea symbolically in the stolen picture of "The Just

[10] Ibid., p. 103.
[11] Ibid., p. 110.

Judges" by Van Eyck, which had formed one of the panels of "The Adoration of the Lamb," set in the altar of the St. Bavon Cathedral of Ghent. In *The Fall* this painting is now stored in the closet of Clamence after having hung for some time in the *Mexico City Bar,* while in the cathedral altar a copy of the original painting substitutes fraudulent judges approaching the innocent lamb. For Clamence the balance of life is thus restored. He says, "Finally, because this way everything is in harmony. Justice being definitely separated from innocence—the latter on the cross and the former in the cupboard—I have the way clear to work according to my convictions."[12]

Thus Clamence, as an individual who has a full realization of his responsibility in the exercise of freedom without any security in the old virtue from which he had fallen, is fully experienced to judge others, to accuse them in their exercise of freedom with responsibility.

Clamence is the mirror of our times, the figure of ourselves. He says ". . . I adapt my words to my listener and lead him to go me one better. I mingle what concerns me and what concerns others. I choose the features we have in common, the experiences we have endured together, the failings we share—good form, in other words, the man of the hour as he is rife in me and in others. With all that I construct a portrait of all and of no one. A mask, in short, rather like those carnival masks which are both lifelike and stylized, so that they make people say: 'Why surely I've met him.' When the portrait is finished, as it is this evening, I show it with great sorrow. 'This, alas, is what I am!' The prosecutor's charge is finished. But at the same time the portrait I hold out to my contemporaries becomes a mirror."[13]

The judge-penitent of Camus is his interpretation of the contemporary liberal humanist. The study of man, conceived as a complete secular being, leads him to the conclusion that man is the cause of his own suffering and guilt, which can be alleviated only to the degree that each individual, through a complete denial of self-interest, attains the right to judge the responsible exercise of freedom in others. Justice and innocence are non-existent. Humanity to move upward toward the summits must become its own *judge-penitent.* The *democracy of guilt* will engender between men that solidarity which will enable them to continue the quest for harmony with life.

For Albert Camus the concept of the judge-penitent is the fundamental and complete explanation of man in all ages. Through Adam, as the figure of the first man, the universality of the guilt of man-

[12] Ibid., p. 130.
[13] Ibid., pp. 139–140.

kind became established in the Judaic tradition at its inception. In like manner John the Baptist inaugurated the Christian era with the same cry of accusation, "You brood of snakes! Who warned you to escape from the wrath that is coming?"[14] Both these patriarchs experienced the complete loss of self-interest in finding the meaning of the solidarity of mankind.

The intensity of this struggle for spiritual solidarity with man and against spiritual isolation by being bereft of it arises from the precarious balance upon which the life of the individual is poised. The slightest misconception of one's own nature at any given moment can plunge one into a tragic impasse. In the concept of Camus it is only the true judge-penitent who is within reach of this kingdom, which has been promised to men of all ages from Adam to John the Baptist to Jean-Baptiste Clamence.

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[14] "The Complete Bible", translated by Edgar J. Goodspeed (Chicago, University of Chicago Press, 1948). Matthew 3, 7.

AMERICAN PROTESTANTISM AND THE MIDDLE CLASS: 1870–1910*

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In the period following the Civil War, Protestantism seemed to face nothing but problems. Those problems raised by Darwinian evolution and by the High Criticism were mainly theological in nature. Change was also taking place in the physical setting. The Civil War had stimulated the growth of American industries, and they were rapidly approaching the proportions of giants. Growing industry in turn accelerated the tendency toward urbanization. The rise of the city and the growth of industry presented practical problems of great importance to the major Protestant denominations, for although American Protestantism had been traditionally rural in its psychology, this approach was now challenged by a new set of physical conditions and by the new social classes resulting from the new industrial society.

The clergy were not prepared to meet the new problems of the city and industry directly, for they had no contact with them. Only very rarely did ministerial candidates come from the ranks of those classes produced by modern industrial society; the very rich and the urban, industrial poor.[1] Charles Stelzle once noted that the average Protestant minister made the claim that having come from a poor home he consequently was in a position to sympathize with the unfortunate. At the same time these ministers completely failed to comprehend the problems of industrial and urban poverty and unemployment. Stelzle made a survey of ministers in relation to this fact and found that fully ninety percent of the ministers that he interviewed in city churches had been born and reared in what might be classed as rural areas. The poverty to which they referred was the simple life of the small town or of the farm which was quite a different thing from the pangs of cold and hunger which he had experienced in city tenements. Leaving their rural areas for college and the seminary, they had no occasion to encounter the realities of city life as it affected the urban poor.[2] Consequently, if

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[1] Walter Rauschenbusch, *Christianity and the Social Crisis* (New York, 1907), p. 301.

[2] Charles Stelzle, *A Son of the Bowery; The Life of an East Side American* (New York, 1926), pp. 82 f. In a sample of 1800 ministers taken in 1930 it was found that only 12 per cent were reared in cities over 100,000 population and 48 per cent came

many ministers through lack of education were unable to comprehend the problems which science and biblical criticism posed for them, they were certainly no more able to comprehend the basic problems encountered among the masses in the cities or of industrial labor. The result was an ever widening rift between the American worker and Protestantism.

To an ever increasing extent, it was the great American middle class that came to sustain the churches of the major Protestant denominations as the nineteenth century progressed. It was becoming ever more clear that the upper and lower strata of society, both from an economic and educational point of view, had by the turn of the century, ceased to lend active support to these denominations. It was now the "solid" and "responsible" middle class that came to be identified with the major Protestant denominations.[3] This included the employers, salaried persons, small tradesmen and farmers. It also included those who had a personal or sympathetic attachment to this class or were engaged in personal service, such as cooks, housemaids, and servants.[4] The ministers readily admitted that their churches were middle class and ministered primarily to that class. Methodism, which had once been the province of the lowly, had profited greatly during the period following the Civil War both individually and collectively. By the turn of the century, Theodore Roosevelt was probably quite correct in stating that he preferred a Methodist audience to any other in America, for they represented to him the great middle class and were in consequence, the most representative church in America.[5]

As the major Protestant denominations came to be principally composed of middle class families, the results were readily apparent in the sermons prepared for such an audience.[6] A very great change in character is to be noted. The clergy of an earlier day read their sermons, priding themselves in their logic and construction. But after the Civil War an attempt was made to make the sermons more interesting and more spontaneous. Henry Ward Beecher soon

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from communities of less than 1000. In this same sample, less than 1 per cent reported the economic status of their parents as wealthy. About 4 per cent said that their parents were well-to-do, and one third reported that their parents were poor. Well over half stated that their fathers were farmers or small tradesmen. Mark A. May, "Theological Education," *The Church Through Half a Century; Essays in Honor of William Adams Brown*, eds. Samuel McCrea Cavert and Henry Pitney Van Dusen (New York, 1936), p. 257.

[3] Andreas Bard, *The Dawn of To-Morrow and Other Sermons* (Burlington, Iowa, 1911), p. 30. Lewis O. Brastow, *The Modern Pulpit: A Study of Homiletic Sources and Characteristics* (New York, 1906), p. 321.

[4] Clinton Locke, *Five Minute Talks; Second Series,* (Milwaukee, 1904), p. 170. Shailer Mathews, *The Church and the Changing Order* (New York, 1907), p. 120.

[5] Charles A. and Mary R. Beard, *The Rise of American Civilization* (New York, 1937), II, pp. 400 f.

[6] Brastow, *The Modern Pulpit,* pp. 325 f. George B. Cutten, *The Psychological Phenomena of Christianity* (New York, 1909), pp. 384 f.

came to speak extemporaneously and was one of the first of the leading members of the clergy to adopt this practice. In fact, Beecher was said to prepare his morning sermons in the hour and a half between breakfast and the time of service. Phillips Brooks soon followed Beecher's example. T. De Witt Talmage brought this movement to its culmination. As orthodox in his theology as he was unorthodox in his presentation, he specialized in bazaar topics for his sermons presenting them with superb eloquence and startling illustrations.[7] However, some ministers still called for a return to the old fire and brimstone preaching of the past.

But the Protestant pulpit could not return to the principles of the past, for beneficial as the Puritan sermons might have been they were not always congenial. Fire and brimstone and the middle class did not seem to mix. The call now went out to preach the "gospel." The movement seems to have started shortly after the Civil War, and it gained momentum as it progressed. The "gospel" seemed to be whatever would not offend a middle class audience. As a consequence it dealt primarily with the past rather than the present. Charles Stelzle received most of his training for the ministry in the school of hard knocks among the Brooklynites and Chicagoites while his more fortunate Presbyterian brethren were in the seminaries immersed in the study of the Amalekites and Hittites. He found that when he preached about the problems of the Pittsburghites, discussing the same questions that his brothers were preaching about in relation to the Jebusites, he was rudely reminded that it would be much better if he would preach the "simple gospel."[8] In preaching the "simple gospel" the average Protestant minister became oblivious of life outside his middle class parish.

In keeping with this genteel middle class sentiment, the church now came to be regarded as the center of social refinement and culture; for it was there that men could learn "many of those arts which add to the beauty and refinement of society."[9] This can be seen in the field of music where it was found that the middle class was attracted by those churches whose music pleased them. Consequently, those congregations that could afford to do so spared no expense in getting the best available artists. Since volunteer choirs were difficult to maintain, and trained choirs proved to be too costly save for the wealthiest congregations, many turned to the profes-

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[7] George Harris, *A Century's Change in Religion* (New York, 1914), pp. 205 f. Leonard Woolsey Bacon, *A History of American Christianity* (New York, 1897), pp. 384 f.

[8] Stelzle, *Son of the Bowery,* pp. 55 f.

[9] The fact that this quotation comes from one of the patriarchs of American Methodism is interesting, for it tends to illustrate that this denomination, which initally contained more of the lower classes of society than others, was striving valiantly for a measure of social prestige. Bishop Matthew Simpson, *Sermons by Bishop Simpson; of the Methodist Episcopal Church* (New York, 1885), pp. 216 f.

sional quartet as did Plymouth Congregational Church, Milwaukee.[10] Congregations now praised God by proxy.

As the major Protestant denominations increased in wealth, ever more attention was given to the art of worship. Cushions were placed in the pews so that the congregations might better appreciate the beauties of the service in greater comfort. Choirs now donned robes as did many ministers, and liturgical forms of greater or less complexity were introduced in the nonritualistic churches. One is no longer surprised to find the use of vestments, processionals, crosses, and even candles in churches which a half century earlier would have scorned their use as a tendency toward "Romanism."[11]

The practice of renting pews seems to have been quite common in this period, especially so in the case of the Episcopal Church. Within this denomination those congregations which had not made this a standard practice prior to the Civil War frequently did so afterwards to ensure adequate financial support.[12] In fact, at a vestry meeting on August 6, 1873, in the Episcopal Church at Muscatine, Iowa, it was voted to collect by suit at law all delinquent pew rents that were more than six months in arrears.[13] It was perhaps not unusual that Baptist churches in Chicago should follow the practice of renting pews, but that the First Baptist Church of Anoka, Minnesota should adopt it as a means of securing a popular minister seems rather surprising.[14] Pews were generally rented to the highest bidder at auction at the beginning of each year; the rate for pews seating five persons varied from less than twenty-five dollars in more modest congregations to one hundred fifty dollars and more in the wealthier. The rental of pews made the church something of a proprietary institution which existed to minister only to those who had been admitted to its membership and paid for its support.

As many churches assumed the proportions of a middle class club for the mutual benefit of the members, it is to be expected that changing vacation habits would be reflected. The practice of taking a vacation for as much of the summer as possible was bound to have its effect. The middle class character of Protestantism is indi-

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[10] Although it called itself an "Institutional Church" it is interesting to note that Plymouth Church consistently spent more for its paid quartet during the 1890s than it did on its entire institutional program. *Plymouth Rock* (Plymouth Congregational Church, Milwaukee, 1890–1900).

[11] Winfred Ernest Garrison, *The March of Faith; The Story of Religion in America Since 1865* (New York, 1933), p. 145.

[12] Bishop H. B. Whipple, *Christian Unity; A Lecture in the Opera House, Minneapolis During the Winter of 1874–5.* MS. Minnesota Historical Society.

[13] J. P. Walton, *History of Trinity Episcopal Church, Muscatine, Iowa* (Muscatine, Iowa, 1892), p. 32.

[14] George C. Lorimer, *Isms Old and New; Winter Sunday Evening Sermon Series for 1880–81 Delivered in the First Baptist Church* (Chicago, 1881), p. 343. Mrs. George H. Wyman, *History of First Baptist Church of Anoka,* MS. Minnesota Historical Society.

cated by the fact that the practice of closing the church doors for one to three months during the summer became increasingly common. During this time the pastor and the congregation alike betook themselves to the seashore or the mountains.[15]

That such congregations should become show places is to be expected. Fashion reigned supreme, especially in regard to women's dress. Competition among women in this respect became so pronounced that the Reverend S. P. Long of Mansfield, Ohio, felt it necessary to state that he could no longer tell the rich from the poor in his audience.[16] Perhaps his congregation contained few if any of the poor. One Episcopal rector stated that the Bible did not in any way prescribe how churchpeople were to dress during the week, but St. Paul did specifically state that women should not dress too extravagantly for church. This comment was brought about by the fact that the women of his congregation seemed to feel that the main purpose of the Sunday service was that it served as a place to display their jewels, fine bonnets, and gowns.[17] As a result of this emphasis on superficial matters, more and more people in the lower income group stayed away from the churches, being in no position to compete in such matters with their employers.

Individual churches and denominational organizations were corporations with all the problems of budgets, building funds and endowments that face such organizations. They found in the post Civil War period that the laity could be utilized for their resources and business abilities. The time was particularly opportune, since the clergy, especially in the Methodist Church, had proven themselves completely incompetent in handling the church's financial and business affairs.[18] In American Methodism prior to 1870 the laity had little control; but with the discovery of not only clerical incompetence but also actual fraud in the handling of the affairs of the Methodist Book Concern in the late eighteen sixties, the demand for the seating of lay delegates in the General Conference grew rapidly. One of the great scenes in American Methodist history occurred at the Meeting of the General Conference in Brooklyn in 1872 when one hundred twenty-nine lay delegates, who had been elected by their local areas, appeared at the door, demanded entrance and were duly seated. Permanent participation by the laity in the affairs of the church was then realized with the election of prominent businessmen and lawyers to the various committees. From this point on the laity came to participate to an ever greater

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[15] George F. Hall, A Disciples of Christ minister in Chicago who was independently wealthy through his presidency of a Chicago corporation, advocated summer vacations for all his members for as long as they could afford to be away. *Temple Addresses* (Chicago, 1909), pp. 342 ff.

[16] S. P. Long, *Prophetic Pearls* (Columbus, 1913), p. 16.

[17] Locke, *Five Minute Talks,* pp. 74 f.

[18] Garrison, *March of Faith,* p. 229. J. M. Buckley, *A History of Methodists in the United States* (New York, 1896), p. 531.

extent in church government and policy.[19] To an increasing degree the business of the church now fell more and more into the hands of laymen, a tendency which was especially apparent in the administration of the Methodist colleges. As the number of wealthy laymen increased they came to take the place of ministers on the boards of trustees. Not infrequently laymen not affiliated with Methodism were given such positions in the hope that they would contribute liberally to the institutions. Wealth and position were now the primary considerations in the election of church committees and institutional boards, not only in American Methodism but in the other major denominations as well.[20]

In the post Civil War period, the successful businessman became the symbol of modern America; and his ideals and methods began to permeate almost every phase of American life. It is not at all strange that the church responded to this influence. More emphasis was placed on efficiency, system, and organization within the churches. The Reverend Charles E. Bronson, pastor of the First Presbyterian Church, Saginaw, Michigan, directed the attention of the church to the need for "more business in religion; more of the directness, energy, adaptation of means to definite ends, concentration of purpose in the Lord's business which we see in secular affairs."[21] As this sermon continues it becomes increasingly obvious that the conception of God has somewhat changed under the influence of industrial society for now, "God is the Great Manufacturer, the great Business Manager of the universe."[22] This tendency toward Christian efficiency did not pass without some opposition, however, for one of the criticisms of the church, especially by the older and more pietistic segments of the congregations was that business meetings were now taking the place of prayer meetings. Such opposition was not able to reverse this tendency, however, and Ernest Abbott found in 1901 that in many places the old Prayer meeting had ceased to exist and elsewhere it was most certainly declining.[23]

The growing tendency toward democracy in the administration of the various churches, together with the increasing participation on the part of the laity, produced a profound effect on the relations of the minister with his congregation. By the turn of the century it was admitted that it was virtually impossible to impose an unwanted pastor on a financially independent congregation. Churches

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[19] Halford Edward Luccock and Paul Hutchinson, *The Story of Methodism* (New York, 1926), pp. 370 ff.

[20] William Warren Sweet, *Methodism in American History* (New York, 1933), pp. 338 f.

[21] Charles E. Bronson, "Christ's Appeal to Men," *The Presbyterian Pulpit; A Volume of Sermons by Ministers of the Synod of Michigan* (Monroe, Michigan, 1898), p. 210.

[22] *Ibid.*, p. 212.

[23] Ernest Hamlin Abbott, *Religious Life in America; A Record of Personal Observation* (New York, 1902), pp. 361 f.

which were being subsidized by missionary bodies might be restricted in their choice, but this was seldom the case when a congregation was sufficiently prosperous to manage its own affairs.[24] In fact, the minister was now more than ever subject to the whims of his congregation, and a great many became nothing more than "cooperatively sustained private chaplains of well-to-do cliques."[25] This dependence upon the congregation continued to increase until, after the turn of the century, there were probably very few preachers, as Walter Rauschenbusch pointed out, who could honestly say that they had never been influenced by the fear of endangering their income when they shaped or delivered their message to their congregation. They were "in bondage through fear."[26]

The Methodists had originally attempted not only to serve their scattered frontier churches in a better manner but also to preserve the independence of their clergy from congregational domination through the use of an itinerant ministry. Originally the time limit was one year, but in 1802 it was extended to two years. This limit was raised to three years in 1864, and in 1888 to five years. In 1900 the limit was removed altogether, and a minister could be appointed to a church indefinitely.[27] Pressure for this change came primarily from the middle class city congregations who wished to retain their ministers if they approved of them, and on the part of the ministers of such congregations who enjoyed a great measure of security, if not of independence. The Reverend Doctor H. W. Thomas of Centenary Methodist Church, Chicago, expressed this feeling in 1877 when he stated that the then existing arbitrary limitation of three years stood in the way of the best efforts for success in the large cities "where the better class become established and want something settled in their pastoral relations with those who shall baptize their children, shall marry them, and shall stand by their graves."[28] Doctor Thomas apparently enjoyed security more than independence.

The rise of a great business civilization in the post Civil War period brought new moral problems to American Protestantism. Perhaps the major denominations were confused by the complexity of the new moral issues, or it is possible that they were blinded by the generosity of those who piously spent a part of the money that they had gained in rather devious ways. Almost every major Protestant denomination profited financially from the increasing concentration of wealth. The speculative activities of men such as

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[24] Emory W. Hunt, *The Genesis of the Sects; A Series of Discourses Delivered in the Ashland Avenue Baptist Church, Toledo, Ohio* (Toledo, 1899), pp. 45 f.
[25] Mathews, *Church and the Changing Order*, p. 122.
[26] Rauschenbusch, *Christianity and the Social Crisis*, p. 304.
[27] Luccock and Hutchinson, *Story of Methodism*, pp. 460 f.
[28] Austin Bierbower, *Life and Sermons of Dr. W. H. Thomas* (Chicago, 1880), p. 254.

Daniel Drew, John D. Rockefeller, and Cyrus McCormick were sometimes called into question; but ministers generally came to their aid, for as one Professor of Intellectual and Moral Philosophy stated, there was nothing essentially wrong with speculation, after all, "A man must think about his business or he will come to grief."[29] Indeed, to gain wealth was now held to be a Christian duty. As the Reverend Oscar C. McCullock put it in 1892, "Wealth is the rich soil in which a human soul-root unfolds its powers and becomes its possibility. God meant that we should flee poverty."[30] But, once a man was rich he must keep in mind that he is only a steward of God's gifts, and the Master would in due time call all the wealthy men to whom he had given gifts for an account of their stewardship.[31] So that rich men could better account to their Master for the use of his gifts, John R. Mott suggested that they follow the "gospel of wealth" suggested by Mr. Andrew Carnegie by giving of their substance to missions and to other worthy causes.[32] In this way Protestantism accommodated itself to a changing economic order.

In addition to this concept of stewardship, Protestantism attempted to prove its usefulness to the middle class by stressing the fact that it was profitable to be a Christian. It was pointed out that the moral and Christian man would always think more clearly and more correctly than would an equally endowed man who was immoral or un-Christian. Godliness was held to be especially profitable in a business career, for it made men sober, economical, prudent, generous, honest, just, industrious, kind, cheerful, and obliging; all of which were held to be essential to success in business.[33] Christianity was not only held to be a very profitable thing for the individual, but foreign missions were described as having done more than any single factor to increase the commerce of civilized nations. It was pointed out that in 1871 all the foreign missionary societies in America spent $1,633,892. on all their fields of labor. Yet the trade with the Sandwich Islands, which had been created as a result of missionary labor, in the same year returned $4,406,426. For every $100. sent out all over the world, this one field of labor had returned $275. The entire cost of Christianizing the Sandwich Islands was less than $1,200,000. But two years' trade paid back that sum, and commerce with the Islands was in-

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[29] David Edwards Beach, *Sermons and Addresses* (Marietta, Ohio, 1890), p. 69.

[30] Oscar C. McCulloch, *The Open Door, Sermons and Prayers* (Indianapolis, 1892), p. 145. Also, D. W. C. Huntington, *Half Century Messages to Pastors and People* (Cincinnati, 1905), p. 164.

[31] M. Loy, *Sermons on the Gospels for the Sundays and Chief Festivals of the Church Year* (Columbus, 1888), p. 526.

[32] John R. Mott, *The Pastor and Modern Missions; A Plea for Leadership in World Evangelization* (New York, 1904), p. 134.

[33] Luther Alexander Gotwald, *Joy in the Divine Government and Other Sermons* (New York, 1901), pp. 92 ff.

creasing every year.[34] Christianity at home and abroad was now profitable in terms of dollars and cents.

From 1870 the major Protestant denominations provided ever increasing evidence that they were participating in the general increase in prosperity. By 1910 they had built costly buildings, provided better music, and made their services more dignified. There was to be found in them an air of culture and urbanity. The message of Protestantism had also been shaped to meet the needs of the prosperous middle class. But while these adjustments were being made, one segment of society had been largely forgotten. A gradually growing group of Protestant ministers realized this situation. Few, however, were as pointed in their criticisms as George D. Herron, pastor of the First Congregational Church, Burlington, Iowa, who in 1892 delivered a sermon on "Unconsecrated Service the Peril of the Church."

> Much of what we call Christianity is no less than an aristocratic and shameless pauperism, thriving on the wealth of sacrifice inherited from the past; resting in high-priced pews and fashionable residences; cunningly squeezing a luxurious living out of humanity, and superciliously labelling as charity the appeals made to serve the humanity that supports it. It is the victorious forces of time the church worships—prudence, thrift, respectability, reputation, culture—while it is practically infidel to the Christian gospel.[35]

Criticisms such as this caused a good deal of discussion but produced little real action. In the long run the middle class remained safe, secure and content in the Protestant Church that they had come to dominate.

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[34] H. A. Gobin, "Co-ordination of the Mission of Christ and the Mission of the Church," *The Kansas Methodist Pulpit* (Topeka, Kansas, 1890), pp. 72 f.

[35] George D. Herron, *A Plea for the Gospel* (New York, 1892), p. 25.

HUGO VON HOFMANNSTAHL AND THE SYMBOLIST DRAMA*

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It is not usual to discuss symbolist drama. We commonly associate the symbolist movement in literature with French poetry of the past hundred years, and it is generally assumed that the interest and importance of the movement is largely limited to poetry. Certainly, it would be difficult to speak of a symbolist novel—although the attempt has been made[1]—and while historians of the theatre, especially in France, have given some recognition to the role of the symbolist movement in the shaping of the modern drama,[2] there has been virtually no attempt to examine from a comparative standpoint the implications of symbolist theory and practice for European drama in the later nineteenth and the twentieth centuries.[3]

It is important at the outset of our discussion to recognize the broad and tentative sense in which the efforts of the French poets and theorists of the later nineteenth century constitute a movement. For despite the programmatic declarations of the young avant-gardists of 1885–95,[4] it is fair to state that *"L'Ecole Symboliste avec un E et un S majuscules ne fut qu'un mythe auquel, seuls, accordèrent créance les critiques hostiles aux directions nouvelles."*[5] We may speak of a common set of attitudes, themes, and techniques which interrelate and give direction to the efforts of Baudelaire, Villiers de l'Isle Adam, Mallarmé, and Valéry, among others, and which we may loosely define as the core of *"le mouvement symboliste,"* but we should also remember that literary symbols were employed long before Baudelaire set forth the aesthetic of *correspondances,* and in a broad sense are part of the resources of any poet. We may speak of symbolic situations, characters, or language in Homer, Virgil, or Dante, without implying any necessary relationship between their works and the poetry of the sym-

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[1] In Edmund Wilson's *Axel's Castle* (New York, 1931), the novels of Joyce and Proust, among others, are discussed as expressions of the symbolist movement in France.

[2] The most recent study is Jacques Robichez, *Le Symbolisme au théâtre* (Paris, 1957).

[3] Perhaps the most serious attempt in this direction is John Gassner's discussion in *Form and Idea in Modern Theatre* (New York, 1956), pp. 97–109.

[4] Their aberrations have been catalogued in full detail by A. G. Lehmann, *The Symbolist Aesthetic in France, 1885–1895* (Oxford, 1950).

[5] François Ruchon, *Jules Laforgue* (Paris, 1924), p. 215.

bolist movement; and yet, there is a particular set of theories and techniques which characterize and define the efforts of the French poets and their confrères, and which, while not the exclusive property of Baudelaire and his followers, nonetheless receive from them a unique emphasis and elaboration as well as a more direct application to poetic thought and expression than we can find in earlier literature.[6] A brief discussion of the fundamental assumptions of French symbolism will help us to understand the symbolist drama and to see how these assumptions affect the dramatic writings of Hugo von Hofmannstahl.

The most important achievements of the symbolist poets in the theatre in France are the dramas of Villiers de l'Isle Adam and Maurice Maeterlinck, which are anticipated in many important ways by Mallarmé's unfinished dramatic poem, *Hérodiade*.[7] To their poetry and drama, Villiers, Mallarmé, and their Belgian disciple, Maeterlinck, brought a poetics which asserted that art was the revelation of a mystery to which the poet alone had the key. In full agreement with the mysticism of Baudelaire, they viewed the poet as endowed with the magical power to perceive the hidden wonder of the universe through analogies and correspondences which he alone can grasp and is capable of translating into his poetry. Dreams, reverie, the unconscious, the visionary or intuitive, all provide direct illumination of the essential spirituality of the cosmos, both in the world of man and that of nature. Through the exploration of his inward vision, the poet can experience this spirituality, and through allusion and suggestion, he can recreate its mystery in his poetry. The language of symbolist drama, like that of symbolist poetry, is richly evocative, expressive of the intensity and depth of the poet's necessarily personal and private experience. Its vagueness together with its musicality makes for a re-creation in the poet's composition of his intuitive and mystical vision, revealing his apprehension and fusion of inner and outer realms of being. Objective reality has no independent existence, but is purified of coarse materiality and incorporated into a higher, transformed reality, the product of the poet's direct and immediate awareness of the spiritual character of all things. The celebration of this spirituality, the evocation not of literal events, but of a mood, an atmosphere, or an "*état d'âme*," animates the dramatic attempts and aspirations of the symbolists just as fully as it lends purpose and direction to their poetry.

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[6] I am aware of the close relationship of French symbolism to the symbolist aesthetics of German romanticism, but there are important differences in emphasis and application as well as in their role in subsequent literary developments. The fullest discussion of this subject to date is Lloyd Austin, *L'Univers poétique de Baudelaire* (Paris, 1956), pp. 78–82 and 139–184.

[7] See my essay, "Dramatic Values in Mallarmés *Hérodiade*," forthcoming in *Stil- und Formprobleme in der Literatur* (Proceedings of the Congress of the International Federation of Modern Languages and Literatures, Heidelberg, 1957).

When we examine the effect of symbolist poetics on dramatic technique, we should not be surprised to find action reduced if not eliminated, character generalized rather than individualized, and language rendered in a consciously poetic style, with all elements of prose subdued, if not refined altogether out of the poet's expression. Symbolist drama is necessarily lyric drama, for the fundamental impulse underlying the concept of the poet and the nature of his activity is derived from lyric poetry rather than from the practical demands of the theatre; and precisely because of the dominance of musicality, suggestiveness, and internalization of experience, symbolist drama is necessarily, to a greater or lesser degree, static drama. It has been argued that there is an inherent contradiction in the very notion of "symbolist drama,"[8] and it is at least clear, even from our cursory description, that the lyric drama and static drama of the symbolist playwrights militates strongly against traditional realistic or naturalistic notions of the nature of dramatic representation.

It is not difficult to understand why a young Viennese poet who began writing at the beginning of the 1890's should be attracted by the symbolist example. Precisely at the time that the unusually precocious Hugo von Hofmannstahl began his literary career, it was the French symbolists who represented what was fresh and experimental in the literature of the day. Brunnettière's proclamation of the bankruptcy of naturalism was echoed by the Viennese critic, Hermann Bahr, in *Die Überwindung des Naturalismus* (1891), and Stefan George, who experienced the full force of Mallarmé's influence on his visit to Paris in 1889, asserted in his *Blätter für die Kunst,* begun in 1892, the primacy of absolute poetry in the face of a society increasingly indifferent or hostile to the claims of art.[9] Hofmannstahl could not escape the impact of his older French contemporaries, The young Hofmannstahl's familiarity with the contemporaries, nor did he attempt to. He was steeped in the tradition of French and German romanticism out of which the symbolist movement developed, and he, like Stefan George, rediscovered the romantic heritage of Novalis, the Schlegels, Schelling, and their contemporaries. The young Hofmannstahl's familiarity with the literature of his time was immense. In his notebooks for 1891 we find, *à propos* of Stefan George, allusions to Baudelaire, Verlaine, Mallarmé, Poe, and Swinburne, to name only a few of his early interests.[10] He knew and loved the poetry of Victor Hugo, the fiction of Balzac, the journal of Amiel, all of which embody attitudes cen-

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[8] Gassner, *op. cit.*, p .108.

[9] See E. L. Duthie, *L'Influence du symbolisme français dans le renouveau poétique de l'allemagne* (Paris, 1933).

[10] See "Aus Hofmannstahls Aufzeichnungen 1890–95," *Corona,* IX (1939), 667. Also see G. Bianquis, "Hofmannstahl et la France." *Revue de littérature comparée,* XXVII (1953), 308.

tral to the symbolist aesthetic. One of his first reviews, to which Hofmannstahl signed the pseudonym of "Loris," was of Amiel's *Fragments d'un journal intime,*[11] in which the Viennese poet was especially struck by the vagueness, suggestivity, and atmospheric evocation in Amiel's depiction of nature, in his concern with the effect of nature *"sur l'état de l'âme."* He singles out for special praise the diarist's preoccupation with the obscure, the half-revealed, the radically subjective,[12] and adds that Amiel's definition, *"tout paysage est un état de l'âme,"* has gained common currency in contemporary France. He may have had in mind Mallarmé's famous remarks to Huret, for the French poet had declared: "Nommer *un objet, c'est supprimer les trois-quarts de la jouissance du poēme qui est faite de deviner peu à peu: le* suggérer, *voilà le reve. C'est le parfait usage de ce mystère qui constitue le symbole: évoquer petit à petit un objet pour montrer un état d'âme, ou, inversement, choisir un objet et en dégager un état d'âme, par une série de déchiffrements."*[13] Hofmannstahl's familiarity with the background as well as the foreground of French symbolism should not make us view him simply as an Austrian counterpart of Mallarmé, but the affinities in his poetry as well as in his lyric drama with contemporary attitudes and techniques in France suggest that his extensive study of French poetry and drama of the nineteenth century entered directly into his own efforts.[14] To describe the young Hofmannstahl as a *"symboliste"* is no more accurate than to label him a decadent, an aesthete, or a *"Neuromantiker,"* and in later life, the poet protested strongly against such simplifications; yet, without forcing interpretation or text, we can find convincing proof of a common set of attitudes and techniques, in a lyric drama that provides a significant expression of the symbolist movement in its European context.

It is instructive to consider Hofmannstahl's critical prose for the light his essays shed on the drama he was writing at the same time. Among the very first of his published writings was a death notice of Théodore de Banville,[15] and it is noteworthy that Banville is praised particularly for his artistic purity and for the dominance of the dream-like and idyllic, not only in his poems, but in his *Comé-*

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[11] First published in the *Moderne Rundschau,* III (1891) and reprinted in *Loris: Die Prosa des jungen Hugo von Hofmannstahls* (Berlin, 1930).

[12] *Ibid.,* p. 44.

[13] Mallarmé *Œuvres complètes,* texte établi et annoté par Henri Mondor et G. Jean-Aubry (Paris, 1956), p. 869. The view that poetry is the expression of an "état d'âme" is perhaps first expressed in Diderot's account of language as a representation of "l'état de l'âme" at a given instant. See Diderot, *Lettre sur les Sourds et Muets,* in *Œuvres complètes* (Paris, 1875), I, 369. Cf. James Doolittle, "Hieroglyph and Emblem in Diderot's *Lettre sur les Sourds et Muets," Diderot Studies,* II (Syracuse, 1952), 148–167.

[14] For a discussion of symbolist affinities in Hofmannstahl's poems, see Duthie, *op. cit.,* pp. 430–445.

[15] *Loris,* p. 61.

dies, "seinen dramatischen Märchen (Fourberies de Nérine, Diane au Bois, Gringoire, Deïdamia etc.) *reinste Traumpoesie, hinausflüchten aus der Welt in eine rosig angehauchte, grazieatmende Transfiguration der griechischen Idyllenwelt. . . ."*[16] We may recall that Mallarmé's *Hérodiade* was originally conceived as a drama modelled in part on Banville's *Diane au Bois,*[17] which also helped to shape the poet's conception of *"L'Après-midi d'un faune."*[18] In many of Hofmannstahl's early reviews, mysticism, musicality, and the suggestive power of language are repeatedly invoked as positive values in the new literature of the time. The interest of the young poet in Swinburne, Pater, the English Pre-Raphaelites, D'Annunzio, and Verlaine, among others, testifies to his transcendent view of poetry, his rejection of commonplace realism, and his rigorous separation of poetry from the anecdotal or didactic, or from the practical exigencies of every-day life.

Perhaps the best illustration of this facet of Hofmannstahl's early development is the lecture of 1896, "Poesie und Leben," wherein he declares: *"ein Gedicht ein gewichtloses Gewebe aus Worten ist, die durch ihre Anordnung, ihren Klang und ihren Inhalt, indem sie die Erinnerung an Sichtbares und die Erinnerung an Hörbares mit dem Element der Bewegung verbinden, einen genau umschriebenen, traumhaft deutlichen, flüchtigen Seelenzustand hervorrufen, den wir Stimmung nennen."*[19] This *"Seelenzustand"* or *"état d'âme"* is evoked by the magical properties of language, musical yet precise, fixed and yet moving, dream-like and yet expressive of the deepest human experiences. By their very nature, words are repositories of both life and dream; the language of poetry, Hofmannstahl insists, must be free from the rhetorical or didactic, from conformity to external reality in any form. Poetry is essentially the expression of inner life, the reflection of the spirituality of the universe through *"die schwebenden, die unendlich vieldeutigen, die zwischen Gott und Geschöpf hangenden Worte."*[20] This view of poetry and the poet, markedly close to the central position of both Novalis and the German romantics, and of Baudelaire and the French symbolists, is re-echoed repeatedly in the critical statements of the young Hofmannstahl. We may see the fruition of his meditations on the symbolism of poetry in *"Das Gespräch über Gedichte,"* published in 1904. Appropriately, the dialogue begins with the citation of poems from George's *Jahr der Seele,* which Gabriel—who seems to represent Hofmannstahl's own views—singles out as expressive of the purest and loftiest beauty. Gabriel's

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[16] *Ibid.*
[17] See Mallarmé, *op. cit.,* p. 1441.
[18] *Ibid.,* p. 1449.
[19] *Loris,* p. 263.
[20] *Ibid.,* p. 266.

poetic theory is based essentially on the symbolist aesthetics of the romantics and symbolists, but he insists that the symbolic view of language take full account of the human origins and human pertinence of poetry. Thus, he cannot accept the statement of his partner, Clemens, that poetic language is symbolic in that *"Sie setzt eine Sache für die andere."*[21] For Gabriel, and presumably for Hofmannstahl, the symbolic character of poetry resides in its power to express the deepest and most intimate essence of things rather than to substitute one object for another. And when Clemens rejoins, *"Es gibt also keine Vergleiche? Es gibt keine Symbole?"* Gabriel replies, *"Oh, vielmehr, es gibt nichts als das, nichts anderes."* Analogies and symbols are inherent in the very existence of things; they are part of the essence of objects, which the true poet reveals in its fullest identity. All poetry, Gabriel asserts, or at least, by implication, all great poetry, *"drücken sie einen Zustand des Gemütes aus,"* that is, expresses an *"état d'âme"*; hence, the primacy of mood creation, of shadowy evocation, of dream and magic in poetry. All poetic objects are symbols, *"eigentlichen Hieroglyphen, lebendige geheimnisvolle Chiffern, mit denen Gott unaussprechliche Dinge in die Welt geschrieben hat."*[22] The poet, through his unique insight into the meaning of these magical signs, may embody them in his poetry, but no literal or complete elucidation is possible. Language in its descriptive function cannot define symbolic values, but the language of the poet is imbued with power to express the magical and the archetypal residing in the world of symbols around us.

The *"Gespräch über Gedichte,"* written at a time when Hofmannstahl had already abandoned the lyric drama and was moving sharply away from George and his followers, mingles symbolist poetics with a more pervasive Platonic mysticism that underlies the poet's preoccupation with the archetypal. In 1904, the symbolic for Hofmannstahl is both the correspondent and the situationally representative. The deliberate concern with general and universal values points toward the poet's later work, but the interest in suggestiveness and mystery stems from the poetic theory which animated his earlier poetry and drama.

It is revealing to compare these views with notations in the poet's notebooks during the period 1890–95. From the beginning of his career, Hofmannstahl embraced the traditional romantic view that the language of poetry is an expression of the divine mysteries of the world, and the essential unity of the cosmos: *"Alles was ist, ist, Sein und Bedeutung is eins, folglich is alles Seiende Symbol."*[23]

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[21] Hofmannstahl, "Das Gespräch über Gedichte," in *Prosa,* II (Frankfurt am Main, 1951), p. 98.
[22] *Ibid.,* p. 102.
[23] "Aus Hofmannstahls Aufzeichnungen, 1890–95," *Corona,* IX (1939), 678.

Hofmannstahl never abandoned his view of the intrinsically symbolic character of objects in the visible world or in the universe at large, but in the course of his development, he moved toward an increasingly personal mysticism, of mixed oriental and neoplatonic origins, which the mature poet incorporated into a total explanation of man and the cosmos.[24] Unquestionably, the affinities in Hofmannstahl's poetic theory and that of the French symbolists are closest at the time when Hofmannstahl took the keenest interest in their work, that is, in the 1890's.

Hofmannstahl's beginning as a writer is marked by his publication in 1891, at the age of 17, of the lyric drama, *Gestern*, to which he affixed the pseudonym of Théophil Morren. We should not underrate the importance of this slight and self-conscious adolescent attempt for our understanding of the structure, themes, and implications, of all of the poet's work of the 1890's. It is plainly incorrect to view *Gestern* as autobiographical in any literal sense,[25] and yet in some measure, the hedonism and passivity in the face of endlessly changing experience is a condition which the poet knew and may have shared.[26] Andrea, the hero of the play, is a typical nobleman and patron of the arts of the Italian Renaissance.[27] He lives lavishly and munificently in a world of pleasure, free from care of any kind. Life he accepts as an endless flow of experiences, existing only in an eternal present, with no past or future. For Andrea, the world is simply the objectivization of his inner feelings; the external universe is but a symbol of the internal:[28]

> *Ist nicht die ganze ewige Natur*
> *Nur ein Symbol für unsrer Seelen Launen?*

Nothing endures beyond the moment, and the way to happiness is through the acceptance of what pleasure the moment may bring.

It is in the subversion of this attitude that the drama of *Gestern* resides. The dream of Andrea's idyllic and essentially false existence is shattered by Arlette's infidelity, by the imposition of the action of another's independent will on Andrea's pattern of life. He comes to learn that he too has deceived himself, that neither

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[24] For an excellent study of Hofmannstahl's mysticism, see Werner Metzeler, *Ursprung und Krise von Hofmannstahls Mystik* (München, 1956). Metzeler recognizes the affinities of Hofmannstahl and the French symbolists but adds, quite rightly, that the Austrian poet's mysticism cannot be explained from a historical, poetic, or psychological point of view simply in the light of somewhat similar preoccupations of the French poets. Cf. pp. 33–35.

[25] For the view that Andrea is a self-portrait, see Karl J. Naef, *Hugo von Hofmannstahls Wesen und Werk* (Zürich, 1938), p. 44.

[26] Cf. "Englischer Stil," *Loris*, p. 172. Valentin Pabst in *Hugo von Hofmannstahls Weg und Wandlung vom Lyriker zum Dramatiker* (unpublished diss., Würzburg, (1952), p. 33, sees Amiel as a direct source of Andrea.

[27] This discussion is based in part on the essay of Richard Alewyn, "Hofmannstahls Anfang: *Gestern*," *Trivium*, VI (1948), 241–262.

[28] Hugo von Hofmannstahl, *Gedichte und Lyrische Dramen* (Stockholm, 1946), p. 235.

the self nor the moment are self-sufficient, that yesterday has continued existence in today. In this sense, what action the play contains issues in a moral generalization defining the destruction of Andrea's inadequate values as the curtain falls.

It should be clear, even from this brief account of the movement of the drama, that altogether in keeping with the constriction of the one act play, almost no physical action occurs; but the paucity of action stems principally from the introspective, meditative character of the hero, as well as from the poetization of inward experience in the language of the drama. The meaning of Andrea's discovery can be expressed only as a realization, as a state of consciousness, and the locus of drama, its crisis and resolution, is necessarily fixed within the mind of the central character. It is clear that *Gestern* turns away from the traditional drama of external events depicted with a high degree of verisimilitude, and substitutes a relatively static drama of internal events.

Hofmannstahl defined the form of his lyric drama in a letter of August 5, 1892,[29] in which he writes of *"Meine Lieblingsform," "das Proverb in Versen mit einer Moral";* and he adds, *"im Anfang stellt der Held eine These auf, dann geschieht eine Kleinigkeit und zwingt ihn, die These umzukehren; das ist eigentlich das ideale Lustspiel, aber mit einem Stil für Tanagrafiguren oder poupées de Saxe."* The immediate origin of Hofmannstahl's "proverb in verse" is in all likelihood the comedies of Alfred de Musset, who constructed such plays as *Il faut qu'une porte soit ouverte ou fermé* precisely in the manner that Hofmannstahl describes above.[30] Yet, the static drama with its internalization of action that we find in *Gestern* is also akin to the technique of Maeterlinck, whose work Hofmannstahl already knew by 1891.[31] It is very likely that he was aware of the high praise accorded to Maeterlinck's early work, both through his keen interest in the Parisian literary scene, and through his close association, from 1891, with Hermann Bahr, who was perhaps the principal intermediary between the French symbolists and the young Austrian writers of the early 1890's.[32] In his volume of 1891, *Die Überwindung des Naturalismus,* to which Hofmannstahl refers in a letter to Bahr of July of that year,[33] and

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[29] Hofmannstahl, *Briefe 1890–1901* (Berlin, 1935), p. 62.

[30] Alewyn, *op. cit.,* p. 258. A somewhat fuller discussion is provided by Bianquis, *op. cit.,* pp. 316–317.

[31] A good discussion of this relationship is provided by S. O. Palleske, *Maurice Maeterlinck en allemagne* (Paris, 1938), pp 122, 132ff. Also of interest are the unpublished dissertations of Adolf Wally, *Maurice Maeterlinck im Drama und in der Kritik Deutschlands* (Wien, 1938), and Silke Brückler, *Hugo von Hofmannstahl und Maurice Maeterlinck* (Würzburg, 1953). Cf. G. Bianquis, *La poésie autrichienne de Hofmannstahl à Rilke* (Paris, 1926), pp. 132–135, and "Hofmannstahl et la France," *loc. cit.,* p. 317.

[32] For the relationship of Hermann Bahr to French symbolism and the symbolist drama, see Heinz Kindermann, *Hermann Bahr* (Graz, 1954), esp. pp. 102–123.

[33] Hofmannstahl, *Briefe 1890–1901* (Berlin, 1935), p. 18.

which we may assume the young poet to have studied with some care, Bahr provides a detailed account of Maeterlinck's earliest dramas and his dramatic theory and technique, emphasizing the rejection of external realism and consecutive linear action, and the deliberate exploitation of suggestiveness which the Belgian playwright derived from his intimate association with the French symbolists.[34] It is impossible to determine to what degree, if any, the conception of lyric drama which Hofmannstahl brought to *Gestern* is based on such early plays of Maeterlinck as *L'Intruse* or *Les Aveugles*. It is probable in any event that in his verse drama of the later 1890's, the Viennese poet drew directly on the work of his Belgian contemporary. What is of special importance for our purposes is not the presence or absence of parallel passages or situations in the plays of Maeterlinck and Hofmannstahl, but the degree to which both playwrights drew on a common romantic and symbolist heritage in the development of their art.[35]

Hofmannstahl's second lyric drama, *Der Tod des Tizian,* was published in the first issue of George's *Blätter für die Kunst,* in October, 1892. It is even more static in movement and more lyrical in expression than *Gestern.* The entire "action" consists only of the creation of a mood, inspired by the imminence of the great painter's death. Much more of an elegy in dialogue than a drama, *Der Tod des Tizian* is a sustained hymn to the greatness of art, a passionate assertion of the mystery of genius and of the superiority of the unseen world of artistic creation to the common world of visual experience. There is neither characterization nor sequential action; only a momentary revelation of truth.

It is when we come to the third of the lyric dramas, *Der Tor und der Tod* (1893) that we find Hofmannstahl creating a play which enters significantly into the repertoire of modern dramatic literature. Yet, the importance of *Der Tor und der Tod* as one of the foremost expressions of poetic drama in the later nineteenth century has been recognized only recently.[36] The play is a landmark in Hofmannstahl's career; and while it is relatively slight in length, its dramatic form is completely adequate to the experience it recreates. In its reduction of physical action, passivity of the hero, and inward focus of revelation, it is clearly an expression of the same symbolist dramaturgy which we have seen in the earlier lyric dramas; but here the arc of life is broader, the dramatic movement deeper and more significant.

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[34] Hermann Bahr, *Die Überwindung des Naturalismus* (Leipzig, 1891), pp. 194–195.

[35] It would be interesting to compare in detail the symbolist aesthetics of Maeterlinck and Hofmannstahl. Maeterlinck's early views are set forth most clearly in his response to Jules Huret, *Enquête sur l'Évolution littéraire* (Paris, 1891), pp. 116–129.

[36] The best general discussion is the admirable introduction of Mary E. Gilbert to her edition of *Der Tor und der Tod* (Oxford, 1945). Also see Ronald Peacock, *The Poet in the Theatre* (New York, 1946), pp. 131–134 and Richard Alewyn, "Hofmannstahls 'Tor und Tod'," *Monatshefte für deutschen Unterricht,* XXXVI (1944), 409–424.

Claudio's predicament is markedly close to that of Andrea. Wealthy, independent, seemingly free from all care, Claudio luxuriates in the splendor of art and in the pleasure of the moment. Yet, he has a far deeper sense of unfulfillment than Andrea. In the long soliloquy which opens the play, we have a vivid expression of the total divorce in Claudio between thought and feeling, art and life. Claudio is from the very outset of the play aware of the artificiality and futility of his life of aesthetic self-indulgence, and in this consciousness of his empty existence lies the source of his transformation.

The visible appearance of Death, followed by the spectres of Claudio's mother, beloved, and friend, creates what Hofmannstahl called in his prologue a "Totentanzkomödie".[37] The medieval dance of death cycles and morality plays undoubtedly underlie the structure of the drama, and there are good grounds for considering it at least in part as "*ein* Faust *kleinsten Formats*",[38] yet, the delineation of the central character is wholly the work of the poet. Confronted with the imminent end of his earthly existence, Claudio exclaims to Death, *"Ich habe nicht gelebt!"* and Death must instruct him in the meaning of life through the evocation of the phantoms of the past. The climax of the play is not Claudio's physical dissolution, but his prior realization of the passionate and purposeful character of life and its interpenetration with death. The imagery in the final lines is of awakening: *"Erst, da ich sterbe, spür ich, dass ich bin."* Claudio's assertion of his identity is the crown of his existence, the revelation of an inner transformation that constitutes the central action of the play. Hofmannstahl's exploitation of the traditional morality structure lends concreteness and actuality to the drama of the soul. For while Claudio is presented as a meditative rather than an active figure, his reflections are constantly moving outward into a context of social relationships.[39] It is a mistake to see *Der Tor und der Tod* as an expression of *fin de siècle* aestheticism; at bottom, it is a critique of aesthetic Narcissism, of the emptiness and futility of a life directed solely to self-gratification.[40] The conclusion of the play is rhetorical. It may well embody a crisis in the personal experiences of the young poet,[41] but its impact is outward: an exhortation to the reader or spectator to reflect on his own existence. Life demands involvement, participation, purposiveness, and we need not wait until our final moment to grasp this central truth.

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[37] Hofmannstahl, *Gedichte und Lyrische Dramen*, p. 178.

[38] Robert F. Arnold, *Das moderne Drama* (Strassburg, 1912), p. 309.

[39] Cf. Peacock, *op. cit.*, p. 132.

[40] Cf. Alewyn, "Hofmannstahls 'Tor und Tod'," *loc. cit.*, pp. 420–421. Also see Hofmannstahl, "Ad me ipsum," *Die neue Rundschau*, 65 (1954), 378.

[41] See Ernst Feise, "Gestalt und Problem des Toren in Hugo von Hofmannstahls Werk," *Germanic Review*, III (1928), 219–228, for an impressive list of parallels of thought between *Der Tor und der Tod* and Hofmannstahl's early essays.

Unquestionably, the structure of the morality play, which was to serve Hofmannstahl many times in the course of his dramatic career, is in large part responsible for the unusual symmetry and coherence of *Der Tor und der Tod.* With the center of action located in the consciousness of the hero, the constriction of time, space, and physical movement is inescapable. Soliloquy is used not so much for exposition as for the creation of mood. The language of the drama moves toward allusion and suggestion rather than toward overt statement. The subordinate characters are spirits, evocations of the hero's past rather than part of an emerging present. Despite the allegorical typifications and the moralistic conclusion, we can see the same symbolist techniques present in *Der Tor und der Tod* as in Hofmannstahl's earlier lyric dramas, but here they are marked by an intensity and depth that gives vitality and richness to the hero's inner transformation. It may well be that with the passage of time, *Der Tor und der Tod* will emerge as its author's finest play, for if it lacks the broad canvas and the philosophical density of the later work, it compensates by its wonderful and altogether satisfying fusion of the demands of poetry and drama. Complex character relationships and conflicts demand a wider arc of life than the one act play can afford, yet within its limits, *Der Tor und der Tod* is effective and absorbing theatre,[42] as well as moving dramatic poetry.

Hofmannstahl's subsequent dramatic compositions in the 1890's are for the most part one act plays in the "Format des *Gestern,*" characterized by the same lyrical and reflective qualities that we have seen in his earliest dramatic efforts. Such plays of 1897 as *Der weisse Fächer, Die Frau im Fenster; Der Kaiser und die Hexe,* and *Das kleine Welttheater,* can all be described as static drama, concerned far more with the revelation of an inner spiritual condition than with external conflict and resolution. In all of these plays of the 1890's we can see a deliberate appropriation of the language and style of lyric poetry; their literary interest is high, and as Hofmannstahl subsequently made clear in *Ad me ipsum,* their autobiographical value is considerable. From the standpoint of the poet's contribution to the modern drama, they represent an intensification of his quest for an appropriate dramatic form. It is these plays of the later 1890's that constitute the closest link between Hofmannstahl and the symbolist drama, for while the Austrian playwright was soon to recognize the conflict beween the literary and the theatrical which a symbolist aesthetic imposed, he turned away from the lyric drama only after he had explored and enriched its possibilities.

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[42] Cf. Herman Bang, "'Der Tor und der Tod' in den Berliner Kammerspielen 1906/07," in Helmut A. Fiechtner (ed.), *Hugo von Hofmannstahl* (Wien, 1949), pp. 326–330.

The impact of Maeterlinck on Hofmannstahl's *Theater in Versen* and other plays of the later 1890's has been studied in some detail.[43] *Die Frau im Fenster* presents marked overtones of *Pelléas et Mélisande* in its dream-like atmosphere, its evocation of the fragility of life, and the heroine's passive resignation to death. The same suggestion that we may see in Maeterlinck's early work of the presence of death lurking in the shadows, silently invading the domain of every-day experience, is also present in *Der weisse Fächer,* a drama of internal separation marked by a deep sense of futility and loneliness; the epilogue is among the most darkly pessimistic utterances in any of Hofmannstahl's works. The décor of his lyric dramas may also owe something to Maeterlinck; the walls, doors, corridors, gardens, fountains, grottoes, and the rest reinforce the shadowy atmosphere and mystery of the action.[44] In *Die Hochzeit der Sobeide* (1899), Hofmannstahl again portrayed the stark isolation and total failure of communication that we find in virtually all of his plays of this epoch. The futility of love, the vague and indecisive utterances, the dream-like melancholy, the pool, tower, and oriental décor, the nostalgia and longing for a deeper, more passionate way of life, the dominance of death, all combine to define the atmosphere and control the action. Despite the intensity of the heroine's self-assertion and the shrill violence of the conclusion, *Die Hochzeit der Sobeide* may rightly be described as the most Maeterlinckian of Hofmannstahl's dramas.[45] The lyric drama as we find it in Hofmannstahl's plays is largely a meditation on life, on cosmic as well as personal destiny, in which the central character reveals his innermost longings and anxieties, in which the individual struggles with himself far more than with other men, and action gives way to dramatic monologue. We have seen the playwright experimenting in this form from his earliest writings, and it is probable that the example of Maeterlinck served not so much to originate as to support and complement his impulses and inclinations—to intensify rather than to control in any fundamental way the direction of his early dramatic efforts.

It is important to take account of the variety of attempt that distinguishes Hofmannstahl's lyric dramas from other plays in the symbolist manner. *Der Kaiser und die Hexe* may be described as static drama in that the action, the liberation of the emperor from the sorceress—begins virtually at the point of its climax, and the emphasis throughout is on the thoughts and attitudes of the central figure. The groundwork of the drama is supernatural and fantastic, while the emperor's progressive realization of his condition is

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[43] See G. Bianquis, *La poésie autrichienne de Hofmannstahl à Rilke,* pp. 132–135. Cf. n. 31 above.

[44] Cf. S. O. Palleske, *op. cit.,* p. 133.

[45] Bianquis, *La poésie autrichienne,* p. 134.

similar in pattern to a morality play. On the surface, *Der Kaiser und de Hexe* is an appeal to activity in the human world as opposed to sensuous and perilous self-indulgence. The emperor learns that the past is a powerful force in the present, and that choice and conduct must be guided by an inner spiritual fidelity. Hofmannstahl later described the liberation of the emperor and his return to the purely human realm as an attempt to reconstitute this world.[46] Unquestionably, the contest between emperor and sorceress is the projection of a personal mysticism imposed by the poet on the drama and from which the salvation of the central character must take its meaning. It is this abstract symbolism, along with the fortuitous and disconnected series of incidents in the play, that weakens its dramatic effectiveness.

Das kleine Welttheater oder die Glücklichen is a morality play of a more traditional stamp, in which the characters are largely abstract typifications. The poet, gardener, youth, stranger, girl, servant, doctor, and madman appear as embodiments of distinct and isolated attitudes. Without names, without a past, without any personal relationships, the characters are nonetheless not mere marionettes; they matter intensely for the vision of life they set forth individually, and for the revelation of the meaning of existence that emerges cumulatively from their utterances. None of Hofmannstahl's plays has so little physical movement, yet the structure of the morality play provides a dramatic framework completely adequate to the philosophical complexity of the vision that unfolds within it.

Like the emperor of *Der Kaiser und die Hexe,* the poet later described the happy ones of *Das kleine Welttheater as "Angehöriger einer höchsten Welt."*[47] Without pausing to summarize the particular ways in which each of the happy ones reveals his or her awareness of the mystery and wonder of the universe, we can see in the movement from the gardener to the madman a panorama of the complexity and variety of man's relation to the cosmos, beginning on the plane of visible nature as sign and symbol of a higher reality, and proceeding in a series of dream-visions to a full and intimate realization of the oneness of the visible and the invisible. The madman is the happiest of all because he sees directly into the mysteries of creation. He represents an "achieved completeness,"[48] in that his whole being has been transformed into an ecstatic vision of the interpenetration and fusion of all the planes of existence, whose individual qualities are described by the earlier figures in the play, but whose spiritual identity is revealed only in the climactic final scene.

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[46] "Ad me ipsum," *loc. cit.,* p. 359.
[47] *Ibid.,* p. 358.
[48] *Ibid.,* p. 365.

At once symbolic and symbolist, *Das kleine Welttheater* is perhaps the fullest expression of the correspondence of visible and spiritual realities in all of Hofmannstahl's work.[49] Its symbolic character rises not simply from the structure of the morality play, but from the interweaving *motifs* and shifting perspectives in which each section illuminates all the others.[50] Its symbolist affinities are evident in the pervasive magic and mysticism of the emerging vision of the universe, as well as in the almost total elimination of external movement for the sake of an inner vision, a collective revelation of an "*état d'âme.*" Critics of *Das kleine Welttheater* have assailed its static quality and condemned it as no play at all.[51] Yet, to demand of it the qualities of a fuller and more objectified drama is to overlook not only its rich poetic language, but also the genuinely dramatic interplay of its separate scenes. Within the minds of the characters, the "action" of the play is not static but intensely dynamic; the internal movement is profound and complete, marked by a unique accord between the resources of the poet and the demands of the dramatic form in which he wrote. A one act morality play could not be markedly different. *Das kleine Welttheater* offers one of the most satisfying illustrations of the fitting together of Hofmannstahl's poetic vision and his conception of the lyric drama.

Hofmannstahl's last important work which may clearly be described as a symbolist drama is the five act play, *Das Bergwerk zu Falun,* written in 1899. Only the first act was published by the poet; the remainder of the play did not appear until after his death. It is a complex and unusual drama, and it would justify much more detailed examination than is possible in this essay. The play is far more personal in its mysticism and symbolism than anything Hofmannstahl had previously written in dramatic form, and it is readily understandable why most commentators have read the play as part of his spiritual autobiography. The hero, Elis Fröbom, is from the very beginning of the drama cut off from common life; a lonely and contemplative sailor, he refuses the consolations of pleasure and society to give himself wholly to a life of introspection and dream. Even on his first appearance, we see that physical reality has no positive value for him. Elis moves from the natural to the supernatural plane of existence as if predestined. The spirit, Torbern, shows Elis the way to the Queen of the Mountain, and under her spell, he resolves to cast off the contingency and mortality of earthly life to become wholly part of her mysterious king-

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[49] The mystical affiliations of the play and its symbolic values are discussed in detail by Gerhart Baumann, "Hugo von Hofmannstahl: 'Das kleine Welttheater'," *Germanisch-Romanische Monatsschrift,* VII (1957), 106–130.

[50] *Ibid.,* p .128.

[51] Cf. Pabst, *op. cit.,* p. 59.

dom and to live for her love. First, however, he must purge himself of all vestiges of earthly attachment. The boundaries between the real and supernatural fade away at the end of the first act, as a boatsman rises as if from the dead to lead Elis to the mines of Falun where he is to work out his salvation.

If the first act of the play is an arresting revelation of the innermost dreams and longings of the hero, and their relation to an unseen and altogether magical realm of being, what follows is almost wholly on the human plane, with only sufficient supernatural evocation to control Elis' movement toward consummation of his mortal life. He falls in love with Anna despite the forces that impel him to cast off the claims of this world, and then deserts her in the moment of their marriage, to lose and to find himself forever in the depths of the mine.

Among Hofmannstahl's early plays, *Das Bergwerk zu Falun* is his most ambitious drama of spiritual transformation, yet after the visionary and magical prelude of the first act, what follows is rooted squarely in the world of common experience. The play has been called the most humanly vibrating of all of Hofmannstahl's dramas;[52] far more richly than the one act lyric dramas, it presents the interplay of character in action. Elis and Anna experience deep love and intense suffering out of their common destiny. The inward stress and strain of Elis is counterbalanced by Anna's growing realization of the futility of her love and the inevitability of Elis' sacrifice of her as the price he must pay for spiritual liberation. For Anna too, at the final curtain the world counts for nothing, and her anguished acceptance of her plight is the final measure of the intensity of her love. Torbern prefigures the supernatural destiny of Elis after the curtain falls, but Anna's fate is on an altogether human plane, and serves to lend actuality and immediacy to a drama that might otherwise reside wholly in mystical transformation.

The affinities of *Das Bergwerk zu Falun* with the earlier plays are striking and important. Elis Fröbom's vision of a life beyond life is an extension and elaboration of the "madness" of *"der Wahnsinnige"* in *Das kleine Welttheater.*[53] In *Ad me ipsum* Hofmannstahl wrote of *Das Bergwerk zu Falun* and *Der Kaiser und die Hexe* as both constituting an analysis of poetic existence.[54] Yet, Elis transcends the world, while the emperor regains harmony with it.[55] Not only the attitudes of the hero of *Das Bergwerk zu Falun,* but the cosmic values implicit in the mysterious realm of the Queen of the Mountain, offer a direct expression of a magical and mystical

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[52] Naef, *op. cit.,* p. 67.
[53] Cf. H. Steiner, "Eine Szene aus dem Nachlass," *Neue Rundschau,* 61 (1950), 178.
[54] "Ad me ipsum," *loc. cit.,* p. 365.
[55] *Ibid.,* p. 359.

view of poetry, derived perhaps from Novalis, E. T. A. Hoffmann, and other romantic sources of the play,[56] and closely associated with Hofmannstahl's concept of *Präexistenz*.[57] The inwardness, mystery, and spirituality common to this play and other symbolist dramas all testify to the close relationship of symbolist and German romantic thought and expression: in *Das Bergwerk zu Falun* we have perhaps the nearest approximation to the quest for *"L'explication orphique de la Terre"* which animated Mallarmé and his followers, and which they shared with the great figures of German literature at the beginning and at the end of the nineteenth century.

If *Das Bergwerk zu Falun* represents a culmination of both a personal mysticism and a series of experiments based upon a symbolist conception of drama, it is also a turning point in Hofmannstahl's art. It has been argued that he did not publish the entire play because of his subsequent rejection of Elis Fröbom's values,[58] but artistic motives may also have played their part.[59] It is difficult to see the character drama as adequately related to the plane of supernatural experience, and it may well be that Hofmannstahl rejected the play because its poetic elements overpowered its inadequately developed theatrical qualities. In any event, *Das Bergwerk zu Falun* may fittingly be described as *"der letzte Ausdruck der offenen Jugendmystik des Dichters."*[60] With it, a major phase of Hofmannstahl's art comes to a close.

In later life, Hofmannstahl was keenly aware of the opposition of the lyric poet and the playwright in his works of the 1890's.[61] The preoccupation with mood, with magic, mystery, and inner spiritual situations militates against any full panorama of social action or complex development of character. The inability of literature to present a total revelation of magical communion calls into question the very role of language in human utterance and communication. *Der Brief des Lord Chandos* (1901) is of central importance in Hofmannstahl's dramatic evolution because it points directly to the danger that a symbolist drama, founded on a thorough-going mysticism, may end as a drama of silence.

In spite of their implicit rejection by the poet, the lyric dramas are not dramas of silence at all, but expressions of sensuous and moving poetry in the theatre. The musicality and magic of Hofmannstahl's idiom is no less effective for the ear than for the eye, and the rich suggestiveness of the verse blends harmoniously with

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[56] Cf. Walter Brecht, "Über Hugo von Hofmannstahls *Bergwerk zu Falun*," *Corona*, III (1932–33), 227–228.

[57] See C. von Faber du Faur, "Der Abstieg in den Berg," *Monatshefte*, XLIII (1951), 1–14; also see Naef, *op. cit.*, p. 68.

[58] Brecht, *op. cit.*, pp. 221–222; also see Pabst, *op. cit.*, pp. 74–77.

[59] Naef, *op. cit.*, p. 70.

[60] Brecht, *op. cit.*, p. 222.

[61] See Hugo von Hofmannstahl and Rudolf Borchart, *Briefwechsel* (Frankfurt am Main, 1954), p. 178.

the fantasy and mystery of the dramatic scene. The lyric dramas are not mere closet dramas. All of them were performed soon after their composition,[62] and the best of them have been presented repeatedly in German-speaking Europe. It is fashionable these days to condemn Hofmannstahl's early plays as "utterly unsuited for the stage,"[63] and some of them may properly be better described as dramatic monologues than dramas; but we must not view Hofmannstahl's efforts to weld poetry and drama through the categories of realistic or representational theatre. Quite apart from the popular success or failure of the Viennese poet's attempt to impose a poetic drama on an indifferent or hostile public, his example remains significant for all concerned with the possibilities of dramatic art.

Hofmannstahl's subsequent development as a playwright moved sharply away from the "Format des *Gestern*" and its symbolist assumptions, toward a more traditional dramatic structure and a more direct concern with character relationships. Nevertheless, it is a mistake to divide his dramas sharply into *Frühwerk* and *Spätwerk*.[64] Many of the themes and techniques of the lyric dramas reemerge in *Jedermann*,[65] *Die Frau ohne Schatten*,[66] *Das Salzburger Grosse Welttheater*, *Der Turm*, and other dramas of the mature Hofmannstahl. If we share the poet's view of the culmination of his career as a playwright in *"Das erreichte Soziale: die Komödien,"*[67] we must also recognize the anticipation of the drama of complex social motives and relationships in such plays of the 1890's as *Der Abenteurer und die Sängerin* and *Das Bergwerk zu Falun*. The later plays are perhaps better known to readers and theatre audiences alike, but in theme and technique they owe much to their author's earlier experiments. Unquestionably, the mysticism of the later work is more elaborate and more personal than the relatively traditional exploitation of mystery and magic in the earlier plays, yet even in the lyric dramas we cannot explain the concern with symbolic and supernatural values merely by analogy with the French symbolists. To call Hofmannstahl's early plays symbolist dramas is not to suggest any conscious attempt on the part of the Viennese poet to imitate his French contemporaries; and yet it is clear that his lyric dramas present striking affinities with the dramatic theory and practice of Mallarmé, Villiers de l'Isle Adam, and

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[62] See R. Arnold, *op. cit.*, p. 307, n. 1.

[63] Hanns Hammelmann, *Hofmannstahl* (London, 1957), p. 22.

[64] For a discussion of the interrelations of the early and later plays, see Naef, *op. cit.*, pp. 91–92.

[65] It is also important to recognize the contrasting implications in *Der Tor und der Tod* and *Jedermann*. On the meaning of salvation in the two plays, see M. E. Gilbert, *op. cit.*, pp. xxx–xxxi.

[66] *Die Frau ohne Schatten* is discussed as a symbolist drama by F. C. St. Aubyn, "Hérodiade: eine Frau mit Schatten?," *Revue de littérature comparée*, XXXIII (1959), 40–49.

[67] "Ad me ipsum," p. 367.

Maeterlinck, and also with the poetic drama of the young W. B. Yeats. In this perspective, Hofmannstahl's dramatic compositions of the 1890's are an important part of an effort to create a modern poetic theatre.[68]

Hofmannstahl's lyric drama is important intrinsically, and not simply because it is the most significant expression of symbolist drama in the literature of the German language. For Hofmannstahl, the lyric drama rests primarily on the intensity and authenticity of his private vision, and on the ability of the poet to invest the theatre with mystery and wonder through his evocative power of language and his penetration into the intuitive and visionary sources of human experience. From Hofmannstahl to the art theatre and the theatre of magic of the twentieth century is but a short step. In the best of his early plays he contributed a freshness and an imaginative freedom which helped to enlarge the boundaries of the art of the drama. Hofmannstahl's early dramas are not the only plays worthy of this praise, but they deserve recognition as dramas which still have distinctive claims on our attention.

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[68] See the stimulating remarks on this subject by Ronald Peacock, *op. cit.*, pp. 147–148.

FENIMORE COOPER AND SCIENCE.* I

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Although science was by no means a primary influence on Cooper, he was not as indifferent to it as has been generally assumed. In fact Cooper offers an interesting illustration of the way in which an essentially conservative American of the early nineteenth century reacted to different aspects of current ideas associated with science, and managed to weave them into the fabric of his total pattern of thought. In the following study, I shall try to explore not only Cooper's references to science itself on a popular level, but the extent to which his general attitudes tended to parallel (and were doubtlessly reinforced by) ideas associated with the science of his day. In addition to his semi-dramatic Leather-Stocking series, which hinges on the tension between nature and civilization, Cooper is important in books such as *The American Democrat* and *Homeward Bound* as the spokesman of American conservatism in both religion and politics. Cooper is worth study not only because of his intrinsic merits but because of his immense vogue; he ranks high among American writers who managed to get his ideas widely read and discussed, among those who were eminently successful in giving Europeans their image of American nature, taste, and ideas. William Charvat's edition of *The Cost Books of Ticknor and Fields* (New York, 1949), covering the years 1832 to 1858, shows how far he outstripped other Americans in arousing a demand for his books. And the *Literary History of the United States* (pp. 623–24), edited by Robert Spiller and others, shows that "at least fifty editions of his work appeared in England in the last twenty years of the nineteenth century," and that even Russia published thirty-two editions of his work before 1927. Whether we today personally like or dislike Cooper, he is obviously, because of his enormous vogue, a very significant index to public opinion and taste, a man whose thoughts even on a subject such as ideas associated with science helps to illuminate social and intellectual history. For the sake of orderly procedure the following study will be divided into successive chapters treating, in part I, 1) the scientists to whose work Cooper was exposed; 2) science in relation to Cooper's other in-

* Grateful acknowledgment is made of the fact that I have been greatly aided in getting this study into its present form through several versions by John Rathbun and David Kuryk, Research Assistants generously provided for this purpose by the Graduate School of the University of Wisconsin. They deserve much credit.

terests such as religion, reason and the idea of progress, and obscurantism; 3) his interest in astronomy and Newtonian parallels; and in part II, 4) his treatment of environment (especially the primeval forest) and heredity (racism) in relation to his theory of "gifts"; 5) his respect for the practical utility of science as advancing navigation and commerce; 6) and finally his use of science in the art of fiction including the management of his plots.

I

1. Knowledge of Science

While Cooper had little systematic introduction to the history of science, he was more familiar than were most belletristic writers (such as Longfellow) with the broad outlines of thought of the major scientists.[1] He was educated at Yale from 1802 to 1805; although the great Professor Silliman did not take up his full teaching duties at Yale until Cooper's last year, his appointment in 1802 led to much sympathetic discussion of the implications of science in that small student body. As Professor of Chemistry and Natural History Silliman emphasized the utility of science and also the idea that in an over-all view science and religion ought to reinforce one another,[2]—two ideas to which Cooper was ardently devoted. Silliman's biographer[3] shows that Cooper regarded Silliman as "his favorite master" and corresponded with him in later life. Silliman had been appointed by Yale's masterful president, Timothy Dwight, who was also devoted to the two ideas mentioned; Dwight was especially known for his crusade against the rational infidelity of the French Revolutionists who (he thought) had perverted the teachings of Sir Isaac Newton and other scientists whom Dwight honored. At Yale Cooper enrolled in a course in astronomy by Professor Day, to whom he refers in his correspondence with Silliman.[4]

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[1] Cooper also knew some scientists personally. He met Cuvier at a dinner. According to his daughter, Susan, Cooper was "quite intimate" with "the celebrated naturalist," Charles Bonaparte (*Correspondence of James Fenimore Cooper*, New Haven, 1922, I, p. 59). While in Rome Cooper met the scientist, Bunsen, and "was much interested in the information he received from him" (Susan Cooper, "A Second Glance Backward," *Atlantic Monthly*, LX, Oct., 1887, p. 481). Cooper also knew the scientific naval explorer Wilkes personally and borrowed from his *Narrative* (1844) for *The Crater* and *Sea Lions* (*Correspondence*, II, pp. 525–526).

[2] Silliman was taught by Robert Hare, the great Philadelphia chemist, who in 1801 discovered the oxy-hydrogen blowpipe as a means of producing great heat for fusing refractory substances. Hare's literary interests are attested by his novel *Standish the Puritan* (1850).

[3] G. P. Fisher, *Life of Benjamin Silliman*, I, pp. 336–337. Cited by Robert Spiller *Fenimore Cooper, Critic of His Times* (New York, 1931), p. 39.

[4] Cooper studied under Silliman in 1804, and in his third and last year at Yale enrolled in an astronomy course taught by Prof. Day, the third professor to whom Cooper wished to be remembered in a letter to Silliman. Marcel Clavel, *Fenimore Cooper, sa vie et son oeuvre: La jeunesse: 1789–1826* (Aix-en-Provence, 1938), p. 152, mistakenly thought that this course was taught by Silliman, and that it was Silliman who influenced Cooper's astronomical reflections in *Satanstoe* and *The Crater*.

In *Switzerland, Part Second* (1859–61 ed., II, p. 62) Cooper calls Francis Bacon "one of the wisest men who had ever lived"; and in *The Crater* (chapter one) he ardently hopes that our colleges may produce another Bacon or Newton. In *Mercedes of Castile* (Lovell-Coryell ed., p. 254) he implies that Bacon represents the introduction of "precise and inductive reasoning" which was to give us so "many accurate and sublime glimpses" of truth, which he contrasts with the benighted superstitions of Columbus' era. *The Prairie* has Dr. Battius, whose scientific pretensions Cooper satirizes, familiar with Buffon and Linnaeus; if Leather-Stocking attacks Dr. Battius for not being able to recognize his own donkey in the dusk, it should be noted that what is being attacked is bookishness as opposed to what might be called inductive Baconian observation.

One can readily find evidence, by using the indexes to Cooper's *Correspondence* and the two volumes of his *Gleanings in Europe* (edited by Spiller in 1928 and 1930), of Cooper's knowing a considerable number of other scientific thinkers. If, as Sir William Dampier says in his *History of Science* (1936, p. 297), Darwin "at once recognized the essence of his own theory" of the struggle for existence in T. R. Malthus's *Essay on Population,* 1798, Cooper's intelligent reference to Malthus helps to illuminate his concern for the larger aspects of the economic struggle for existence among human beings as not incompatible with a divine providence which is benign. Cooper's most extended and enthusiastic discussion of any one scientist involves LaPlace, whose *Celestial Mechanics* extended and reinforced Newtonian astronomy; Cooper in *Gleanings* used LaPlace to illustrate how the scientific proof of design in the cosmos reinforced belief in a divine designer as well as awe and reverence. *The Crater,* where this view is elaborated, also testifies to his veneration for Herschel. Beyond Silliman,[5] the scientist whom Cooper knew best personally was S. F. B. Morse, a painter and a scientist both utilitarian and religious. In Morse's *Memorial of James Fenimore Cooper* (New York, 1852, p. 36), Morse testifies, "We were in daily, almost hourly intercourse while in Paris during the eventful years of 1831, 1832 (when Morse was developing his telegraph, finally demonstrated successfully in 1844). I never met with a more sincere, warm-hearted, constant friend. No man came nearer to the ideal I had formed of a truly high minded man." The spirit of piety behind Morse's science is illustrated by the fact that the first words he chose to transmit by his invention

[5] Silliman, like Cooper, was intensely religious. In 1839 he argued that geology proved "the harmony of his (God's) revealed word with the visible creation" (Fisher, I, p. 385). Silliman's attempt to justify the Bible through geology was attacked in a famous controversy by Thomas Cooper in 1833. But many scientists felt like Silliman. In 1836 Plymouth Academy in New Hampshire started a new course on "anatomy and natural history, as illustrating the Divine Existence" (E. Douglas Branch, *The Sentimental Years,* New York, 1934, p. 35). And Agassiz in his *Essay on Classification* (1857) said science discovered the thought of the creator.

were, "What hath God wrought?" Cooper acknowledged it was his "good fortune to be an intimate acquaintance" of Morse, "a distinguished citizen" who would "transmit his name to posterity, side by side with that of Fulton."[6]

Cooper was also closely associated with DeWitt Clinton, U. S. Senator and governor of New York (1817–22, 1825–28) who was devoted to the application of science to practical problems and mainly instrumental in developing the Erie Canal (1825), which Cooper eulogized, and also the canal from Lake Champlain to the Erie Canal and the Hudson River. Cooper's *Correspondence* and *Gleanings* not only show his long intimacy with Morse and Clinton but with other utilitarian scientists such as the British John Loudon McAdam whose scientific experiments "finally transformed most of the highways of the island (England) into the best of the known world"; according to Cooper's view, "few men have conferred more actual benefit on Great Britain." But in the United States, through applied science, Cooper concluded that "we have actually done as much in the same time as England, in canals, railroads, bridges, steam-boats, and all those higher improvements, that mark an advanced state of society. These are the things of which we may justly be proud, and they are allied to the great principle on which the future power and glory of the nation are to be based." The reader should bear such a statement carefully in mind as counter-balancing Cooper's fictional praise of the illiterate (and primitive?) Leather-Stocking and his concern with what appears to be obscurantist piety. If a transcendentalist such as Thoreau might have attacked the things Cooper listed as evidence of a deplorable materialism, it is noteworthy as characteristic of Cooper's kind of religion that he welcomed applied science as a means of implementing Christian charity and as a means to advance the good life in a practical and paternalistic way for all the people.

Cooper's close association with Dr. James DeKay,[7] his family physician and fellow-member of the Bread and Cheese Club, was one of several sources for Cooper's important belief in the current theory which DeKay elaborated in a published *Address on the Progress of the Natural Sciences in the United States* (New York, 1826) as the great "chain of beings" which provided scientific and cosmic sanction for acceptance of a parallel doctrine of the rightness of social gradations[8] as opposed to the kind of equalitarianism

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[6] *Sea Lions* (Lovell-Coryell ed., New York), p. 127, Chap. 10.

[7] In *Gleanings in Europe: France* (Phila., 1837), reprinted with an Introduction by Robert Spiller (New York, 1928), Cooper addressed several chapters to his friend De Kay, including discussions of industrial arts and animal magnetism.

[8] De Kay, in his *Anniversary Address on the Progress of the Natural Sciences in the United States* (New York, 1826), p. 68, notes that everyday discoveries of fossil remains, "insensibly" leads men to admit that "the idea of a chain of beings is neither visionary nor unphilosophical." And on page 40, he writes that "Zoologists themselves leave too often overlooked the history of man, as if he was not a link in the great chain of animated nature."

associated with Thomas Paine. Cooper was also friendly with Dr. John W. Francis, his family physician during the later part of his life;[9] Robert Spiller (*Cooper, Critic . . .*, p. 296) thinks Francis "sat for the portrait of that admirable physician, Dr. McBain, in *Ways of the Hour*," 1850. It is quite possible, since he quoted from Swift among the mottoes which preface the chapters of his novels, that Swift's hilarious satires of scientists for their oddities may have inspired Cooper to satirize physicians such as Dr. Sitgreaves of *The Spy*, but this tendency appears to have involved comic relief of a literary sort rather than any deep-seated hostility toward medical science.

Cooper's concern with the benefits of applied science appears to have been reinforced by his very favorable review of Parry's book on his quest for the Northwest Passage and by his enthusiasm for Charles Wilkes' *Exploring Expedition* during the years from 1838 to 1842. Cooper was of course much concerned with naval science, as is illustrated at great length in his *History of the Navy of the United States* (1839) and the fact that nearly a dozen of his novels, beginning with *The Pilot* deal with ships. In books such as *Jack Tier* (1848) he devotes much satire to the misuse of naval terms and the urging of a more accurately scientific use of them. A recent study by Warren Walker[10] defends the authenticity of Cooper's naval terminology. His two years in the navy, reinforced by his personal inclinations, led Cooper to dramatize his devotion to the need for social gradations and a hierarchy of command in terms of naval life which illustrates his scientific theory of the ladder-like "great chain of beings" throughout nature serving as a model for orderly social life. The scientific theory of the "great chain" was also popularized in Alexander Pope's *Essay on Man*, I, 233–240, in Akenside's *Pleasures of Imagination*, first version, II, 323–50, and in Thomson's *Seasons* (*Summer*), lines 333–37; we know that Cooper was closely familiar with these authors because he selected from them quotations to preface (and adumbrate the action of) several of his chapters. He also knew Alex von Humboldt, whose *Cosmos* contained (Vol. II, pp. 1–105) a chapter on the Poetic Delineation of Nature.

Cooper's *Monikins* (1835) makes extensive if satirical use of Lord Monboddo's pre-Darwinian notions of evolution as expressed in his *The Origins and Progress of Language* (1773). Monboddo associated man and the ourang-outang as species of the *genus Homo*, although he was a creationist and did not suggest transmu-

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[9] Cooper, through De Kay perhaps, knew several of the leading men in the medical profession. In *Afloat and Ashore* (Lovell-Coryell ed., New York), he mentions such people "as Hosack, Post, Bayley, M'Knight, More, etc., and even thought of procuring Rush from Philadelphia." (p. 422, Chap. 28).

[10] Warren S. Walker, "Ames Vs Cooper: The Case Re-Opened," *Modern Language Notes*, LXX (Jan., 1955), pp. 27–32.

tation. *The Crater,* as H. H. Scudder's studies have shown in detail, shows Cooper was very familiar with and made extensive use of Lyell's evolutionary geology. It has been suggested that Cooper may have been introduced to Monboddo's notions of evolution and men with tails by Thomas Love Peacock's novel *Melincourt,* 1817, which aimed, Peacock said, to satirize "perfectibilians, deteriorationists, status quo-ites, phrenologists, transcendentalists, political economists, theorists in all scientists. . . ."

Cooper made considerable use of the current psychological theory of associationalism involving ideas and moods evoked by actual historic geographical places (such as Fort Ticonderoga in *Satanstoe*) and also a belief in the primacy of what Cooper called "the bias of the feelings" as opposed to rationalism. This theory, as elaborated by David Hartley and Joseph Priestley, not to mention William Wordsworth as interpreted by Wisconsin's Professor Arthur Beatty, was ultimately based on Sir Isaac Newton's *Principia.*

If The Leather-Stocking Series represents a semi-dramatic fictional treatment of the tension between primitive nature and civilization, another series crusading against the anti-rent movement (*The Littlepage Manuscripts,* made up of *Satanstoe, The Chainbearer,* and *The Redskins*) show Cooper as the sophisticated and intellectual defender of a conservative and cultured social order, as do *Homeward Bound* and *Home as Found.* Educated at Yale, moving in the cultured circles of upper-class English and European society for seven years (1826–33), a member of the Bread and Cheese Club of New York made up of intellectuals such as W. C. Bryant and Dr. DeKay, a host to celebrities at Cooperstown, Cooper must have heard much about the trends of science in a popular way by word of mouth. Miss Dorothy Waples' *The Whig Myth of James Fenimore Cooper,* 1938, based on a Yale dissertation, shows how closely, in watching for libels on himself, Cooper read the newspapers and magazines, a practice which must have done much to keep him abreast of discussions of science on a popular level. Evidence about his wide reading may be extended by reference to his daughter Susan's introductions to the novels in the Household Edition, 1874, 1881–84, and to her articles entitled "A Glance Backward," and "A Second Glance Backward," in *The Atlantic Monthly,* LIX (1887), pp. 199–206; LX (1887), pp. 474–487. Even the belletristic reading which he did, embodied a good many popularizations of ideas associated with science, as many recent studies of scientific influence on literature have amply demonstrated.

The following pages will show how Cooper utilized science to buttress his own attitudes toward man, society, and God and how science was often used to enhance the quality of his fiction.

2. Cooper's Attitude Toward Science

Religion, Reason, and Social Progress

The matter of Cooper's religion is highly important, underlying as it does, in part, his literary, scientific, and political interests. He never swerved from his belief that nature was a revelation of God (second only to the Bible) and that the metaphysical basis of natural law discoverable there, served to substantiate unchanging moralities and inalienable human rights. But while nature might give a philosophy of religion, it was incapable of giving a theology of religion. The point is important. Cooper sometimes deprecated the "vain-glory" of intellect and "philosophical theology" when they opposed themselves to faith and good works and failed to "substitute humility for pride of reason." His episcopalian, trinitarian beliefs eventually led him to vigorously attack partisan sects. He roundly denounced Unitarianism as a godless abomination shamelessly pushing onward with "the goal of infidelity in open view."[11] It was "utopian" to think that everyone could be reduced to the same economic, educational, and social levels.[12] He had complete faith in God's "unwavering rules of right and wrong."[13] Man had to formally acknowledge that he was wholly dependent upon "the hand that does not suffer a sparrow to fall unheeded."[14]

With such intellectual certitude as to the reality of God and the need for religion, and with such faith in reason rightly disposed, it was inevitable that Cooper would see the discoveries of science as confirming his own beliefs. The sailor who lived in the "immediate presence" of God's work came to see a "parallel" between the "grandeur" of the natural world and the "grandeur which seems inseparable from images that the senses cannot compass."[15] Man, he wrote in *The Heidenmauer,* "is not left without the powerful aid of that intelligence which controls the harmony of the universe" (p. 59). We share with God a portion of his attributes. We can peer into nature and discover its intricate parts, its complex harmony which is complete proof of a superior harmonizer.

In spite of the inanities and crudities that Cooper, as a satirist, had a faculty for finding in the society around him, he did, in his own way, believe whole-heartedly in the progress of humanity toward an ultimate perfection. "For ourselves, we firmly believe that the finger of Providence is pointing the way to all races, and colours, and nations, along the path that is to lead the East and the

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[11] *The Redskins* (1846 ed.), II, pp. 129–130.
[12] Quoted by Robert Spiller, *Fenimore Cooper, Critic of his Times,* p. 313.
[13] Preface to *Oak Openings* (Lovell-Coryell ed., New York), p. 5.
[14] Preface to *The Sea Lions* (Lovell-Coryell ed., New York), p. 5.
[15] *The Pathfinder,* p. 1.

West alike, to the great goal of human wants."[16] "The main course is onward," he wrote, and he busied himself with showing how it was to be effected.[17] In American history he saw "the prodigious progress of the people in morals, public and private virtue, honesty, and other estimable qualities,"[18] great advances in the sciences,[19] in in commerce and resultant prosperity.[20] At times he could see the first dim glow of the dawn of a glorious new political era.[21] The progress of Occidental civilization, with America as its crown, he thought an "inscrutable and grand movement of Providence" from the savage ages of "furious superstitution and debased ignorance" through the borrowed and magnificent yet sordid time of Rome, the feudal violence and "its progeny of wrong," and finally the struggle of monk against baron which had brought about much that characterized modern Europe.[22]

In the United States, at least, Cooper seemed to see progress operating on a certain semi-evolutionary and nonstatic pattern which in turn required the existence of certain definite conditions. Some of his best books were written in illustration or argument of these points. The basic pattern of American progress seemed, quite naturally to one whose father had been a genteel pioneer, the progress from a first time of mutual struggle and privation when "mere animal force" reigned to the detriment of higher social values. In the natural course this passed into a second period when wealth commenced the struggle resulting in "gradations of social station that set institutions at defiance." This was a time of struggle and ruthless competition, and Cooper felt that he was living in the midst of its greatest activity. Eventually a "third and last condition of society" would be evolved, when society would be divided into "more or less rigidly maintained" castes.[23] This would be the era of the gentleman, when men of wealth would accept their responsibility and be repaid in privilege. The central idea of "gradation" of which Cooper speaks is obviously associated with the great hierarchical "chain of being" interpreted by De Kay, Cooper's scientific friend.

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[16] *Oak Openings* (New York, 1873 ed., P. Appleton and Co.), p. vi. Unless otherwise specified, all further references to Cooper's novels will be to this edition of his works.

[17] *Oak Openings,* p. vi.

[18] *Afloat and Ashore,* p. 165. *Wing and Wing* is a full-length attack on the French deistic rationalism embraced by Raoul.

[19] *Notions of the Americans,* Letter XXIV, in *Fenimore Cooper: Representative Selections,* ed. Robert Spiller (New York, 1936), p. 21.

[20] *Ibid.,* Letter XXXVII, p. 39ff.

[21] *Ibid.,* Letter XXXVIII, p. 64.

[22] *The Heidenmauer,* p. 440.

[23] *Home as Found,* pp. 188–189. This theory of the three stages of civilization may possibly be derived from Condorcet, but the idea was a popular one in America. Timothy Dwight, president of Yale when Cooper was there, developed much the same idea in *Travels in New England and New York* (1821); so did Benjamin Rush in his essay on "The Progress of Population in Pennsylvania" (included in his *Essays,* 1798).

Cooper's political and social thought thus had reference to his idea of the gentleman. His religion taught Cooper that the gentleman was also the man who conformed to moral laws and patterned his life on church precepts. His knowledge of science convinced him that there was a "scale of being" ordained by God. Even within the species there was gradation, with the gentleman occupying the topmost rung. The concept of the great chain of being was reinforced by the order-giving appearance of Newtonian physical theory. In the eighteenth century it had been bolstered by the idea that throughout the universe there was a plenitude of beings of almost infinite gradated forms. The idea of plenitude was further confirmed by nineteenth-century findings in geology and botany and by what was revealed through the microscope. Many men, like George Bancroft, found in Lyell's researches countless gradated species. But even before Lyell this was current thought; Erasmus Darwin voiced it, and it could not have been unfamiliar to Silliman. Cooper could have found the great chain idea in *Animated Nature* of Goldsmith, whose biography his friend Irving wrote. And it seems possible that his boon-companion of the Bread-and-Cheese Club as well as his personal physician, Dr. James De Kay, acquainted him with the doctrine.

Men believed that the design of the universe showed God's unity, wisdom and power, and hence the need for humility, devotion, and gratefulness in man.[24] Cooper was constantly referring to the "order-giving touch of the Creator.[25] He thought that the Deity's "intelligence" in controlling the "harmony" of the universe was paralleled in the moral order.[26] In *Sketches of Switzerland* he held that God had established "equitable laws, and implanted in every man consciousness of right and wrong, which enables the lowest in the scale to appreciate innate justice."[27] He felt that true piety was based on knowing one's position "in the long scale of animated beings."[28] Consequently in *The Heidenmauer* (Lovell-Coryell ed., N. Y.) he censured the religious hermit who turned from society. "The task assigned to man is to move among his fellows doing good, filling his part in the scale of creation, and escaping from none of the high duties which God has allotted to his being; and greatly

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[24] This was the thought, for instance, of Yale's Denison Ohnsted's *Letters on Astronomy*. See Merle Curti, *The Growth of American Thought* (New York, 1943), p. 322.

[25] *The Headsman*, p. 494.

[26] *Wing and Wing*, p. 48.

[27] *Sketches of Switzerland* (Phila., 1836), pp. 113–114. Lovejoy, *The Great Chain of Being* (Cambridge, 1933), p. 206, claims that the great chain "gave a metaphysical sanction to the injunction of the Anglican catechism: each should labor truly 'to do his duty in all that state of life'—whether in the cosmical or the social scale—'to which it hath pleased God to call him.'" This is a good expression of Cooper's idea as well.

[28] *Satanstoe*, p. 482. In *Ways of the Hour* (p. 297), he held that democratic institutions are good in causing "every person to feel that he is a man, and entitled to receive the treatment due to a being so high in the scale of earthly creations."

should he be grateful, that, while his service is arduous, he is not left without the powerful aid of that intelligence which controls the harmony of the universe." (p. 41, Chap. 3). It was this belief that the order of the universe was seconded by order in the social body that led Cooper to expect such high things of America and to be so brutally disappointed when it became apparent that sin was a destroyer of order. His turn to religious thought, then, is explicable as an attempt, through religious guidance, to return man to that state of order ordained by God as the natural condition of the universe and society.

This inequality in the hierarchy of nature had to be frankly recognized in political and social life. Thus in *The Monikins* one of Cooper's sober conclusions is that "nature has created inequalities in men and things, and, as human institutions are intended to prevent the strong from oppressing the weak, *ergo,* the laws should encourage natural inequalities as a legitimate consequence" (p. 452).[29] Cooper has his hero Captain Truck in *Home as Found* tell the Commodore of the Lakes, "I have been captain of my own ship so long that I have a most thorough contempt for all equality. It is a vice that I deprecate. . . . I am of opinion that equality is nowhere borne out by the Law of Nations [he constantly cites Vattel]; which after all, commodore, is the only true law for a gentleman to live under. . . . That is the law of the strongest, if I understand the matter, general . . . Only reduced to rules." (p. 323).[30] The aristocratic Signor Gradenigo in *The Bravo* defends his vested interests "by analogies drawn from the decrees of Providence." He argues that because God had established "orders throughout his own creation, in a descending chain from angels to men," men ought to enforce a similar order in human society" (p. 99). No expedients," Cooper concluded in *The American Democrat,* could "equalize the temporal lots of men" (p. 190). The thought runs like a musical theme through practically all of Cooper's writing. It received early treatment in *The Prairie,* where Dr. Battius spoke of the "links of harmony, order, conformity, and design" between men and animals (p. 223). Mark Woolston's education at Princeton, while it had "not made him a Newton or a Bacon," had fitted him for a particular social level that was unassailable and differentiated him from other classes.[31] Everywhere there was inequality, in America the "unavoidable result of the institutions" which the

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[29] The circumstances indicate that here Cooper is speaking in his own voice and has for the moment abandoned the Swiftian satire. For background see Willi Muller, *The Monikins von J. F. Cooper, in ihrem Verhaltnis zu Gulliver's Travels von J. Swift* (Rostock, 1900).

[30] In *Homeward Bound,* Captain Truck is glamorized in contrast to the exponent of equality Steadfast Dodge, the unscrupulous journalist. Cooper satirized Dodge as viewing "all things as gravitating towards the great aggregation" and hence losing all individuality (p. 101).

[31] *The Crater,* p. 16.

founding fathers, acknowledging the lesson taught by nature, had set up.[32] For since men were by nature unequal, in "order not to interfere with the inequality of nature, her laws must be left to their own operation, which is just what is done in democracies."[33] The great chain theory fitted in nicely with Cooper's own emphasis on individuality, and indeed probably was a contributing factor. The result for Cooper was a justification for a natural caste system, that each man should know "his own place in the social scale" and forget the falsehood that he is "as good as another either in nature or in social relations, in political axioms any more than political truths."[34]

Important differences between Cooper and other believers in progress should be noted. He was far from agreeing with rationalistic spokesmen of the Enlightenment such as Paine and Barlow that human nature could attain perfection through science alone. When Dr. Bat tells Natty in *The Prairie* that scientific education might "eradicate" the principle of evil, he is brought up short by a retort so clear and conventional that it shows Cooper excitedly forgetting to keep the fictional Natty in character. "That for your education," is Natty's answer, as he snaps his fingers. "Cruel enough would be the order that should come from miserable hands like thine! A touch from such a finger would destroy the mocking deformity of a monkey! Go, go, human folly is not needed to fill up the great design of God. There is no stature, no beauty, no proportions, nor any colors in which man himself can well be fashioned that is not already done to his hands."[35] Cooper had no sympathy for reform based only on abstract justice without a concern for circumstances and practicality, and he was furious at the Northern violators of the Fugitive Slave Act whom he thought obstructed the proper solution of the problem by slow emancipation.[36] Nor was there anything primitivistic about Cooper's idea of progress. In accord with current racial theories, he thought it perhaps fitting that "the red man disappears before the superior moral and physical influence of the white."[37]

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[32] *The American Democrat* (1838 edition), p. 83. Unless otherwise specified, all further references to this book will be to this edition.

[33] *Ibid.*, p. 78.

[34] *Afloat and Ashore,* p. 399.

[35] Dr. Bat also has overtones of Holofernes. See Edward P. Vandiver, Jr., "Cooper's *Prairie* and Shakespeare," *PMLA,* LXIX, (Dec., 1954), p. 1302–1304. At no time did Cooper fail to recognize the importance of the supernatural in the scheme of progress, although, as we shall see, his emphasis on this aspect differed in degree during certain periods of his writing.

[36] See *New York,* ed. with an introduction by Dixon Ryan Fox (New York, 1930), p. 33, where Cooper fulminates against the "machinations of demagogues and the ravings of fanaticism." See also Dorothy Waples, *James Fenimore Cooper and the Whig Myth* (New Haven, 1938), p. 41.

[37] *Notions of the Americans* (Phila., 1839), II, p. 277. On Cooper's non-Rousseauistic theory of progress see John F. Ross, *The Social Criticism of Fenimore Cooper,* University of California Publications in English, III (1933), pp. 2, 17–18.

In the non-fictional *Gleanings in Europe: France,* the basis of Cooper's optimism appears as a tacit faith in the beneficence of the universe as revealed by astronomy and as interpreted by La Place. The "vast and beneficent design" of nature would seem to provide an example it would profit man to follow. Cooper's own order-loving temperament fitted him to speculate on the economy of the cosmos. If a comet has sometimes no apparent nucleus, and aerolites are formed into pure iron by a natural process in the atmosphere, then perhaps, he thought, the fixed stars that sometimes unaccountably disappear, become comets and later condense into solid matter to take up regular planetary orbits, establishing thereby a "regular reproduction of worlds to meet the waste of eternity." Furthermore, if as many astronomers believed, the solar system, along with the thousands of other systems, revolved around some central focal point in the universe, Cooper's pious imagination designates this point as the throne of the Most High (p. 250). Such scientific considerations of the omnipotence of God awakened in man a sense of his insignificance and the need for humility. It was no matter for disbelief that the petty affairs of the forked radish inhabiting this small portion of the universe should be as yet imperfect, the throne of the Most High having larger issues to contend with.

Much of Cooper's thought is confusing unless it is studied in the light of the genetic development of his mind and attitudes as a whole. The nationalistic optimism of Cooper's earlier views of progress rested on current scientific views of environmentalism, racism, and freedom of thought. *The Bravo, The Heidenmauer,* and *The Headsman* set energetically to work to prove the superiority of the new American liberalism to Walter Scott's version of the dark and bloody past.[38] Even on his return from Europe, on the threshold of bitter disillusionment, Cooper wrote with conviction that "the heart of the nation . . . is sound."[39] Manufacturing, based on scientific inventions, seemed about to sky-rocket.[40] And religion was deserting silly sectarianism. But quarrels with the unbridled press and a natural reaction following, the contrast between the ideal America he had glorified in Europe with the everyday actual America he now observed began to jaundice his critical eye. He complained of the irresistible tendency toward mediocrity in a nation where the common mind so imperiously rules.[41] He became

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[38] Thomas Lounsbury, *James Fenimore Cooper* (Boston, 1882, p. 123, records that Italian censors refused to permit the publication of *The Water-Witch* in Rome because of its unfavorable comparisons of the vanished glory of the Eternal City with the rising might of youthful America.

[39] *Correspondence,* I, p. 328.

[40] *Fenimore Cooper: Representative Selections,* p. 39ff.

[41] See *Home as Found* (Lovell-Coryell ed., New York), p. 79, Chap. 7. It should be pointed out that Cooper always distrusted scientific theories which seemed to him to point toward a completely materialistic universe or concept of man. As his religious

a conservative, not because he was temperamentally reactionary or because he thought old times better than new, but because he felt the movement of American civilization to be away from true progress—which included a caste system based on free competition and the great chain of being. The *Letter to His Countrymen* (1834) saw Cooper attacking the press, Congress, and the Presidency. But it ended with a return to the former optimism, postdated: "the democracy of this country is in every sense strong enough to protect itself. Here the democrat is conservative, and, thank God, he has something to preserve."[42]

The final conviction reached by Cooper as age, weariness in the warfare of ideas and customs, and a hardening of the religious arteries grew upon him can be illustrated from virtually all his later works. Cooper still felt that the world was advancing, although he was skeptical of some of its features, but he wondered if perhaps progress might not be due as much to unthinking accidents as to the design of man. In *Oak Openings* he summarizes almost perfectly his view that rationalism needs the support of revelation:

> When men tell us of the great progress that the race is making toward perfection, and point to the acts which denote its wisdom, its power to control its own affairs, its tendencies towards good when most left to its own self-control, our minds are filled with scepticism. The everyday experience of a life now fast verging toward three score, contradicts the theory and the facts. We believe not in the possibility of man's becoming even a strictly rational being, unaided by a power from on high; and all that we have seen and read, goes to convince us that *he* is most of a philosopher, the most accurate judge of his real state, the most truly learned, who most vividly sees the necessity of falling back on the precepts of revelation for all his higher principles and practice. We conceive that this mighty truth furnishes unanswerable proof of the unceasing agency of a Providence, and when we once admit this, we concede that our own powers are insufficient for our own wants (Lovell-Coryell ed., pp. 357–358, Chap. 26).

The obscurantist, withdrawn, and, in a practical sense, pessimistic trend of the foregoing is obvious. It was echoed in the Preface to *The Crater,* in the statement that God's providence in government would effect an eventual happiness if man did not interfere with his eternal talk about "the people, the people."

Indeed, the whole message of *The Crater* is that man may build a Paradise on earth with the materials God has given him if he em-

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views developed into a kind of quietism, the hand of God was seen more and more as guiding human affairs, social improvement being incidental to moral reform. Principles of natural causation like environment and heredity were less stressed than God's providence.

[42] It is possible to comb anti-progressive sentiments out of the conversation of the Leatherstocking series, if one disregards the dramatic propriety of Natty's utterances. In the light of the whole sweep of progress, Natty must be regarded as the potent agent of the very first stirrings of civilization in the American wilderness. His annoyance at its advance, then, cannot be taken to represent Cooper's own feelings as a whole.

ploys the right principles, but that the wrong principles and methods of American publicity, social levelling, economic exploitation and sectarian strife could destroy it in a short time. He scored the man of science for intellectual presumption. Instead of extolling the "pride of reason" the scientific man should be brought to "feel that profound reverence for Him that the nature of our relations justly demands."[43] Christianity was at once the goal and the means of progress. "Do we then regard reform as impossible, and society to be doomed to struggle on in its old sloughs of oppression and abuses?" he pretended to ask. Cooper's answer was that Christianity would be a "faultless" guide to the future. "In due season this code [of Christianity] will supersede all others, when the world will, for the first time, be happy and truly free."[44] Cooper's ideal, apparently, would be that of his old Yale teacher, Silliman, devoted to *both* scientific rationalism *and* Christian revelation.

If the religious scientist Silliman seems to be Cooper's living ideal, Columbus in *Mercedes of Castile* (1840) may be perhaps his fictional counterpart. Cooper praises Columbus for his knowledge of the more advanced geographical and astronomical science of his era: "this extraordinary man had many accurate and sublime glimpses of truths that were still in embryo as respected their development and demonstration by the lights of precise and inductive reasoning."[45] While Cooper finds Columbus has a "profound deference" toward most of the Catholic doctrines, he was scientifically advanced in thinking that most miracles came about "through the agencies of nature" and he was sceptical about a recently reported miracle in which "real tears were seen to fall from the eyes of the image of the holy Maria. . . ."[46]

As a Christian, it is noteworthy that Cooper wrote of Columbus as "not strictly a devotee; but a quiet, deeply-seated enthusiasm, which had taken the direction of Christianity, pervaded his moral system, and at all times disposed him to look up to the protecting hand of the Deity and to expect its aid."[47] Such characteristics are common to all the heroes and heroines of Cooper's extremely religious later period, but they can be observed, in nascent form, in all his writings. Cooper was habitually influenced by his own theories of ontologism and morality, and his characters are admirable or inferior according to the way they paralleled Cooper's beliefs. Universal sympathy was not a Cooper attribute. Today we might see Cooper's depiction of Columbus as of a rarified, idealized sort; but to Cooper Columbus was man as he should be, pious, temperate, im-

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[43] Preface to *Sea Lions* (Lovell-Coryell ed., New York), pp. 3–4.
[44] *Oak Openings*, p. 272.
[45] *Mercedes of Castile* (Lovell-Coryell ed., New York), p. 254, Chap. 18.
[46] *Ibid.*, p. 269, Chap. 19; and p. 174, Chap. 13.
[47] *Ibid.*, p. 165, Chap. 12.

bued with the highest sense of being a disciple of God. Thus Columbus sets as his main mission in life the fulfilling of God's designs by spreading the Gospel over the earth.[48] Only secondarily does he think of the wealth that may be derived from the Orient; much of Cooper's dis-esteem for Ferdinand of Aragon stems from that monarch's putting material matters foremost.

Coincident with Columbus's pietism was the scientific temperament which contributed so much to his personal stability. Columbus "entered little into the popular fallacies of the day."[49] Instead, he relied "on demonstration and probabilities—a course that the human mind, in its uncultivated condition, is not fond of taking."[50] Columbus's "notions had got the fixed and philosophical bias that is derived from science,"[51] and in them he had sharply differencast by the earth in the eclipses of the moon." Columbus asks tritiated himself from those "who were too little accustomed to learned research properly to appreciate the magnitude of the proposed discoveries."[52] Thus with true scientific detachment, Columbus answers to the queries on Prestor John that "I find no scientific or plausible reasons to justify me in pursuing what may prove to be as deceptive as the light which recedes before the hand that would touch it."[53] He was, too, far from "the weakness of thinking" that attributing manifestations of nature to "direct miraculous agencies," but thought, as Lyell and other scientists of Cooper's time thought, that it was "more in conformity to the practice of divine wisdom" to utilize natural means for one's advancing in the ways of the world. "My thoughts," says Columbus, "have first been turned to the contemplation of this subject; then hath my reason been enlightened by a due course of study and reflection, and science hath aided in producing the conviction necessary to impel myself to proceed, and to enable me to induce others to join in this enterprise."[54]

There is no doubt that his Columbus repeats some of the favorite dicta of Cooper himself. Columbus, of course, as Cooper admits, was "necessarily subject to much of the ignorance of the age,"[55] yet is much too intelligent to pass up "such aids as may be gleaned from science"[56] or to neglect "the every-day laws of nature."[57] He could be prone to error, as when he neglects to follow up his surmise that the difference in degrees between the north star and the

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[48] *Ibid.*, p. 53, Chap. 4.
[49] *Ibid.*, p. 89, Chap. 7.
[50] *Idem.*
[51] *Idem.*
[52] *Ibid.*, p. 86, Chap. 7.
[53] *Ibid.*, p. 90, Chap. 7.
[54] *Ibid.*, p. 207, Chap. 15.
[55] *Ibid.*, p. 89, Chap. 7.
[56] *Ibid.*, p. 226, Chap. 16.
[57] *Ibid.*, p. 245, Chap. 18.

compass needle might be due to "regions where the loadstone abounds,"[58] and explaining the divergence instead as caused by the movement of the north star. Cooper speculates on whether Columbus was resorting to a ruse to reassure the seamen or whether he actually meant what he said: "No person of any science believed, even when the variation of the compass was unknown, that the needle pointed necessarily to the polar star. . . ."[59] Yet Cooper thinks it not improbable that Columbus was capable of "uttering so gross a scientific error, at a time when science itself knew no more of the existence of the phenomenon than is known today of its cause."[60] Thus there was some extenuation. In all, the regard that Columbus entertained for nature as "a legislator that will be respected" and his faith that science was capable of unlocking many of the secrets in the material sphere, as well as his simple confidence in a protective, benevolent God, serve to illustrate Cooper's own attitudes toward these matters.

If progress was to be made, then, it would best be made with minds culturally independent, capable of adapting the sciences to man's end but never losing sight of the fact that man's ultimate goal is the glorification of God. His learning had taught him that nature was a "vast and beneficient design," that its order had the kind of stability at least partially open to reasonable analysis. It was a mistake to think that scientists could set themselves up as so many gods; but scientists, when properly reverential, could help much in the forwarding of the affairs of the human race.

b) *Obscurantism*

Cooper was persistent in admitting the efficacy of science in meliorating the condition of mankind. He was equally persistent in refusing to admit that science was the key to man's universal emancipation. Placed in its proper position and properly subordinated, science was a useful tool; but it was not the be all and end all of human accomplishment. Throughout his career as a writer Cooper urged men to recognize "the imperfections of human powers," to avoid "the vain-glory of intellect," to avow the need for substituting "humility for pride of reason," to stand properly awed before a "mandate of a wisdom that is infinite."[61] Cooper held to no rigid anti-rational position. It was simply that man boasted too much of his reason. And he held in contempt those men who like Ishmael Bush were "ignorant of the application of any other intelligence than such as met the senses."[62]

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[58] *Ibid.*, p. 242, Chap. 17.
[59] *Ibid.*, p. 253, Chap. 18.
[60] *Ibid.*, p. 254, Chap. 18.
[61] *The Pioneers*, pp. 136–138.
[62] *The Prairie* p. 80.

In *The Prairie* Cooper uses the straw-man Dr. Obet Bat, the "philosopher of nature" who studies Buffon and Linnaeus, as a means of satirizing the extreme view that science alone has the power to eradicate all evil from the world. Symbolically, Dr. Bat is mounted upon an ass. He scoffs at Natty's simple belief that all the beasts were "literally collected" in the Garden of Eden (p. 207). The ultimate arrives when Dr. Bat scientifically catalogues the enormous physical dimensions of a "new" beast he has "discovered"—and finds he has come across his own jackass moving along in the dusk. He finds fault with the formation of all quadrupeds and can't decide which scientific means of locomotion would improve them, the principle of the lever or the wheel. And when he argues that education and science can end evil, Natty sees such faith in rationalistic knowledge as "mortal wickedness," a symbol of man's impious "pride and vanity" (p. 224).[63]

The fault with such men as Dr. Bat lay in their perversion of reason. No one, not even scientists, as Cooper remarks elsewhere, can "tell us what is life and what is death. Something that we cannot comprehend lies at the root of every distinct division of natural phenomena."[64] The attitude thus early begun was an intrinsic part of Cooper's artistic and spiritual development, resulting in the religious novels of his last years. The "sublimest facts taught by induction, science, or revelation"[65] may well turn out to be alike or at least complementary, but when Mary Pratt asserts that "this boasted reason" was insufficient to explain "a single mystery of the creation" one can see Cooper affirmatively nodding his head from behind his pen.[66]

Even Cooper's theories of education, which deserve exhaustive study, involved in later life a marked limitation in order to emphasize fallible man's dependence on God. In *The Crater,* after Mark's election to governor, he screens the admission of new colonies to avoid importing "moral diseases" into his "body politic" and takes care that the children are not taught anything they should not know. Mark absolutely forebade teaching the youngsters that the human mind was infallible. Everything was orientated toward religious truth (p. 415). One cannot help but note how different Cooper's educational view is from that of Paine or Jefferson, both of whom believed in complete freedom of ideas and in debating all

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[63] Allowance should be made for the possibility that in creating Dr. Battius, Cooper as a disciple of the satiric Swift is in accord with a literary convention which used the scientist for comic relief. See for orientation, C. S. Duncan, "The Scientist as a Comic Type," *Modern Philology,* XIV (1916), p. 281ff. In contrast to Natty's simple Moravian beliefs, one should contrast Cooper's years at Yale, his wide reading, his association with such well-educated scientists as Dr. De Kay, and his habitual exaltation of education as essential to the cultivated social order of intelligent gentlemen.

[64] Preface to *Sea Lions,* p. 7.

[65] *Ibid.,* p. 9.

[66] *Ibid.,* p. 118.

conflicting beliefs. In the light of Leatherstocking's pugnacious opposition to Dr. Battius's scientism, it is more than probable that if Cooper had his way such scientific ideas would not be offered for free debate in schools, although its utility and power to stimulate man's awareness of the Creator would be taught. If we are tempted to ridicule Cooper's educational views, it is well to remember that today (1959) probably a majority of Americans believe that educators should limit or focus ideas presented in American schools in such a way that Communism should not appear superior to democracy.

Cooper's marked taste for Swiftian satire makes it likely that it was the follies and foibles of man rather than science *per se* that engaged Cooper's attention. *The Monikins* is a wholesale satire of practically all scientific studies. Yet Cooper we know was pro La Place and pro Lyell, numbered many friends among scientists, and always regarded science rightly used as indispensable to progress. Law, medicine, religion, all come in for their share of ribbing in *The Crater*. Mark feels that while law as a science is "a very useful science" such a science might be done without for a few years (p. 325). One doctor is sufficient for the expedition, for it is "better to die under one theory than under two" (p. 325). And man is so contrary and contentious that it is almost impossible to have a priest for every religious persuasion (p. 325). In *Upside Down, or Philosophy in Petticoats* (1850) Fourierism, Owenism, and the Brook Farm doctrines, the new-fangled ideas of the 1840's that Cooper thought an insult to the age, are held up for mockery.[67] And the naive way in which trusting souls look to science for the cure of the world is held up to ridicule in *Jack Tier*, where the credulous Aunt tells her niece Rose Budd, who is well, that the voyage was taken to benefit Rose's pulmonary condition, that "hydropathy" was to be the cure (p. 76). The satire on Dr. Sitgreaves, who urges the American soldiers to saber the British in such a way that he can stitch them up neatly as a surgeon, is based on Smollett's satiric art.[68]

Regarding the sea, Cooper felt that the "interminable waste of water" inspired an unscientific attitude toward life. Even scientific explanations for natural phenomena tended to buttress a seaman's general credulity. "Where is the seaman," asks the *Red Rover*, "who has not, on some evil day, been compelled to admit that his art is nothing when the elements are against him?" (p. 264)[69] No matter how a man may have fortified his thinking proc-

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[67] See John Kouwenhoven, "Cooper's 'Upside Down' Turns Up," *The Colophon*, n.s., III (1938), pp. 524–530. Fourier tried to derive his utopian notions of "social attraction" from Newtonian science.

[68] Dr. Sitgreaves was taken over directly from Lee's book about an actual physician in the Revolutionary War who had such a comic quirk.

[69] *Red Rover* (Lovell-Coryell ed., New York), Chap. 20.

esses, superstition was a quality that seemed indigenous to the ocean. It led the less gifted seaman at every step of his pilgrimage, to seek relief of some propitious omen. The few omens which are supported by scientific causes give support to the many which have their origin only in his own excited and doubting fancy.

Cooper's true attitude toward science was early set forth in *Notions of the Americans* and remained fairly constant even though his emphasis changed. Intelligence was the affair of all. It was the preregotive of no one to "pronounce on the boundaries which the Almighty has been pleased to set between the efforts of our reason and his own omniscience" (I, 1839 ed., p. 108). It was good to express humility while approaching the great body of undiscovered truth. But it became almost a sacred duty to tax the "faculties to the utmost" and to investigate "the truth in its more useful and practical forms." Intelligence was "the parent of all that is excellent and great in communities" (I, 1839 ed., p. 108). This at first seems to strangely contrast with *The Crater* where Cooper belittles science for its lack of religious humility. But like Hawthorne, Cooper actually appears to have wanted intelligence *and* reverence (the heart) to be developed in counterpoised and harmonious balance. There was in Cooper's final period (*cf. Oak Openings*) a great deal of religious resignation. God and not man forwards human events. But all history went to show that God after all found it most to His liking to consummate His desires through natural means. The business of man then became one of obedient humility, refraining from imposing his will before the Divine will, and recognizing that the finite cannot completely fathom the Infinite.

Thus Raoul in *Wing and Wing* has a vision of the truth and is converted to a belief in God by the contemplation of the stars and his knowledge of astronomy. Scientific pride is cooled and the "insignificance of our being" affirmed. Cooper condemned rationalism and scientific deism as often leading to sheer atheism by attributing events "to fate or fortune instead of to God." It was a "dreadful evil" caused by the "shallow philosophy so much in fashion" (p. 478). Because God was incomprehensible He merited worship. That was why the Indians, child-like in notions and behavior, never raised "hollow objections" to the incarnation of Christ. Cooper well knew the Biblical injunction that only as we act as children shall we enter the Kingdom of Heaven. In Cooper's time men aspired too high. "It is when we begin to assume the airs of philosophy," he wrote in *Oak Openings* (p. 399), "and to fancy, because we know a little, that the whole book of knowledge is within our grasp, that men become skeptics." Always the Creator's work will "exceed the power of human comprehension" and "transcend our understanding" (p. v). From *Notions of the Americans to Oak Openings*

Cooper turned to a denial of the principle of intellectual freedom and a belief that indiscriminate reading is dangerous to morality. Quietism was reinforced by dogmatism. Yet science had its value, and when properly understood and properly used, was of inestimable value to man's spiritual and material welfare.

3. Cooper's Scientific Interests

a. *Astronomy*

Astronomy was to Cooper one means of arriving at an awareness of God's power and design. Cooper had been introduced to astronomy at Yale and had reacted to it as his hero Corny Littlepage reacts to its study in *Satanstoe*. And in *The Crater* Cooper wrote that "in impressing the human race with a sense of the power and benevolence of the Deity, we think the science of astronomy, with its mechanical auxiliaries, is to act its full share. The more deeply we penetrate into the arcana of Nature, the stronger become the proofs of design; and a Deity thus obviously, tangibly admitted, the more profound will become the reverence for his character and power" (p. 153).

About 1831, writing of the eclipse of the sun he had seen as a boy, he said nothing had ever given him a clearer idea of the "majesty of the Almighty" and the insignificance of man. "It seemed as if the great Father of the Universe had visibly, and almost palpably veiled his face in wrath. But, appalling as the withdrawal of light had been, most glorious, most sublime, was its restoration."[70] He ridiculed those "philosophers" who refused to believe in eclipses because they had not seen one. From his early days as a sailor wondering at the silent majesty of the stars which guided his ship, to the later *Crater* and *Gleanings in Europe: France* he glamorized the science of astronomy as not only practically useful to mariners, but as inspiring as awe which reinforced faith in a Divine and Benevolent Designer.

In *Mercedes of Castile,* a story whose action begins in Spain in the year 1469 and involves Columbus, Columbus is made out as seeking to "prove the wisdom of God by actual experiment;"[71] and the science glorified is astronomy and navigation. Cooper remarks that at that time: "The revolution of the planets, the diurnal motion of the earth, and the causes of the changes in the seasons, were then profound mysteries even to the learned; or, if the glimmerings of the truth did exist, they existed as the first rays of the dawn dimly and hesitatingly announce the approach of day."[72] He treats sym-

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[70] "The Eclipse," *Putnam's Magazine*, n.s., IV (Sept., 1869), p. 358.

[71] *Mercedes of Castile* (Lovell-Coryell ed., New York), p. 106, Chap. 8.

[72] *Ibid.*, p. 144, Chap. 11. On p. 150, Cooper proceeds to ridicule those who at that time supposed the earth was not round.

pathetically Columbus's empirical reasonings to demonstrate the roundness of the earth, such as the fact that at sea what one sees of an approaching ship is the top-sails, and the round "shadows cast by the earth on the eclipse of the moon." Columbus asks triumphantly, do not observers "see that these shadows are round, and do they not know that a shadow which is round can only be cast by a body that is round?"[73]

The sea predisposed Cooper toward a sense of awe and mystery. In *Sea Lions,* he spoke of it as having the aspect of eternity, without beginning or end, in ceaseless movement, its dangers prompting one to belief in a protective Providence who alone prevents our being abandoned to the domain of chance.

La Place was one of the main figures on whom Cooper depended for much of his knowledge of astronomy. Such a man was alone "sufficient" to "redeem" the French from the imputations that they were no more than "dancing-masters, *petits maîtres,* and *perruquiers.*" Astronomy was of practical concern. But it could also strike sparks "from the spirit of some dormant Newton" and inspire "a contemplation of the power and designs of God."[74] Indeed, this last point is the keystone to Cooper's attitude toward astronomy. Science could be bad and lead to the extreme of pride, or it could be good and cause the scientist "to humble himself and his utmost learning, at the feet of Infinite Knowledge and power, and wisdom, as they are thus to be traced in the path of the Ancient of Days![75] A knowledge of astronomy, Cooper felt, could breed a "truly philosophical indifference" toward the insignificant earth. "Admiration of human powers, as connected with the objects around me, has been lost in admiration of the mysterious spirit which could penetrate the remote and sublime secrets of the science; and, on no other occasions, have I felt so profound a conviction of my own isolated insignificance, or so lively a perception of the stupendous majesty of the Deity."[76] There was no "risk" involved in the study of astronomy when such study could lead men to consider God's omnipotence, although, he wrote, "it certainly might be dangerous to push our speculations too far."

Mark Woolston's knowledge of and attitude toward science in *The Crater* can pretty much be taken as Cooper's own. Cooper, after his initial study at Yale, continued to interest himself in astronomy while in the navy and afterwards when he had occasion to meet scientists at the various New York clubs and during his extensive travels. Mark similarly pushed on in his studies and found that they made him "a somewhat more accurate astronomer"

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[73] *Ibid.,* pp. 159–161, Chap. 12.
[74] *Gleanings in Europe: France* (Spiller ed.), p. 248–9.
[75] *The Crater,* p. 155.
[76] *Gleanings in Europe: France* (Spiller ed., 1928) p. 249.

than he might otherwise be (p. 154). Both Mark and Cooper were aware of Herschel and the consequences for philosophy of his discoveries. But their similar attitudes toward nature and God are most important. Both moved from a study of the skies from a sense of "curiosity and a love of science," to a point where astronomy helped them determine their own position in "the scale of created beings."[77] In Cooper's final period it became all important to see in the heavens "the hand of God instead of the solution of a problem."[78] Thus when Mark views the stars through his telescope, the feeling flows over him that they testify to the "existence of a vast and beneficent design," prompting him to "love and adoration" for the "Divine First Cause," "the dread Being which had produced all these mighty results" (p. 154).

b. *Newtonian Parallels in Political Ideas*

Cooper's use of Newtonian physical thought is not so all-embracing as his comparable use of astronomy, but in a study of scientific influence on his writing it should be considered. Cooper's political and social ideas were highly important in determining his creative bent and are often characterized in Newtonian terms. One-sided greed and self-indulgence follow a law associated with the correspondence between material and ethical laws. Because people were greedy, checks and balances are necessary to neutralize the conflicts of greed. For Cooper, the equilibrium of the moral order was under constant threat. Discussing the evil miser Goldencalf in *The Monikins,* Cooper points out that the lust for gold was self-perpetuating. "This is a moral phenomenon that I have often had occasion to observe, and which, there is reason to think, depends on a principle of attraction that has hitherto escaped the sagacity of the philosophers, but which is as active in the immaterial as is that of gravitation in the material world" (p. 40, Chap. 3).

Gravitation was also used to explain what Cooper regarded as the tendency of democracy toward mediocrity. He pointed out in *The American Democrat* (1838 ed.) that only numbers count in a democracy and hence a "high standard" is difficult to form. All the arts, including literature, tended "to gravitate towards the common center" rather than rise to a superior plain (p. 71). Cooper found that in Europe the "extremes of society" are mutually re-

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[77] Yet even later Cooper could be enthralled with astronomy for its own sake. In *The Sea Lions* (Lovell-Coryell ed., New York, pp. 277–280, Chap. 22), he interrupts the course of the story to explain the physical reason for seasonal change so that even the "most clouded" mind could understand it.

[78] In *Wing and Wing,* even as he is dying, Raoul's devotion to astronomy as the idea of God as merely a "principle" retards his acceptance of God as a person. Astronomy has seized on Raoul's fancy but not his heart. As he dies, Raoul ponders on whether other planets are inhabited and imagines man's inventing " 'instruments to trace the movements of all these worlds' " and calculating " 'their wanderings with accuracy for ages to come.' " (pp. 476–477).

pelling, while in America the tendency is to "gravitate toward a common center." "Thus it is, that all things in America become subject to a mean law that is productive of a mediocrity which is probably much above the average of that of most nations, possibly of all, England excepted; but which is only a mediocrity after all."[79]

Cooper also used physics to explain how the oscillation in American life from one extreme to another was like the swing of a pendulum. He thought that "public opinion, however, like all things human, can work evil in proportion to its power to do good. On the same principle that the rebound is proportioned to the blow in physics, there can be no moral agent capable of benefitting man that has not an equal power to do him harm.[80] Cooper wrote that as soon as men's minds reach the saturation point they recoil to the opposite extreme. "Men are constantly vibrating around truth, the passions and temporary interests acting as the weights to keep the pendulum in motion."[81] In discussing "American Principles," Cooper states that: "It is a general law in politics, that the power most to be distrusted, is that which possessing the greatest force, is the least responsible."[82]

The theory of checks and balances in Cooper's political thought also has reference to Newtonian physics. Many political thinkers in America, John Adams for instance, justified the tripartite division of government by analogy with Newtonian thought. They felt the Constitution was "the best example of the ideas of mechanics applied to politics, and thought of society as a microcosmic universe, in which the laws of cohesion and repulsion analogous to those of the physical world operated according to the arrangements of their creator, the wise maker of constitutions. In a very real sense, we in the United States, live under the Newtonian system."[83]

Cooper's ABC letters of 1835 answered Daniel Webster's arguments that a strong executive power was unjustified, and his *Letter to His Countrymen* claimed that the United States really had a system of checks and balances whereas in England it was a fiction whereby money actually ruled. "So admirable," he wrote in *Notions of the Americans,* "is the practise of checks and balances throughout all the departments of this government, and so powerful and certain is the agency of public opinion, that no political management, except in cases that, by common consent, are thought to come fairly within the scope of political maneuverings, can easily be exercised" (II, 1839 ed., p. 226). And in *The Monikins* (p. 414)

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[79] *The Sea Lions,* p. 11.
[80] *The American Democrat,* p. 156.
[81] *Gleanings in Europe: England,* ed, with an introduction by Robert Spiller (New York, 1930), p. 187.
[82] *The American Democrat,* p. 28.
[83] Theodore Hornberger, *Scientific Thought in the American Colleges, 1638–1800,* (Austin, Texas, 1945), pp. 86–87.

Cooper used the doctrine of centrifugal and centripetal action to satirically explain the "rotary" action of politicians oscillating from party to party: "Their great rotary principle keeps them pretty constantly in motion, it is true; but while there is a centrifugal force to maintain this action, great care has been made to provide a centripetal counterpoise in order to prevent them from bolting out of the political orbit."[84]

The general scheme of Newtonian law being in balance so long as it is not interfered with provided a real basis for Cooper's belief in laissez-faire economic theory.[85] When commerce remained in its proper sphere and forebore to wield any "direct influence in politics" Cooper had no quarrel with it, although this was a condition he rarely saw in a society burgeoning into a bourgeois state of ostentation and money-grabbing. Very early he wrote that "The secret of all enterprise and energy exists in the principle of individuality."[86] The function of government was a benevolent forebearance characterized by "physical advantages" and "fortified by its moral and intellectual superiority" which enabled it "to leave man to the freest and noblest exercise of his energies and will. . . ."[87] It is, he wrote, a "well-established principle . . . that trade will make its own laws." "Trade issues its own edicts, and they are ordinarily found to be too powerful for resistance, wherever there are the concentrated means of rendering them formidable by the magnitude of the interests they control."[88]

It was all to the good of American well-being that manufacturing should be left "to the operation of natural influence." Cooper

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[84] Many scholars have noted Cooper's continual references to Newton when he wishes to show the rightness of a belief or action. His admiration for Newton never faltered. Mr. Frank Collins, in an unpublished University of Wisconsin dissertation (1954), notes that the "extent of the novelist's dependence upon the conception of the universe associated with Newton is indeed everywhere revealed in his writings, not only in his accounts of the vast harmony perceived in the heavens but even in his casual allusions and analogies." p. 773. There are many examples of this. In *The Chainbearer,* for instance (p. 341), Mordaunt Littlepage observes that the members of the Thousand-acres' family were probably "just as well satisfied with their land-ethics, as Paley ever could have been with his moral philosophy, or Newton with his mathematical demonstration."

[85] Robert Spiller says that Cooper "accepted . . . without question" the laissez faire optimism of political thinkers of the period" who "saw no reason why competition and altruism should not co-exist" (*Fenimore Cooper: Representative Selections,* p. 330). A fruitful field of inquiry still remains open regarding Cooper's reaction to the vogue of Malthus in the United States, and how Malthus might have helped reinforce the great chain theory and Newtonianism in general in inducing Cooper's belief in laissez faire. From Cooper's reference to Malthus in *Gleanings in Europe: England* (p. 322), it is evident that he knew his work, which Darwin admitted first suggested his idea of the struggle for existence as a result of the fact that population outruns food supply. Cooper would undoubtedly have been familiar with the ideas Robert Hale expressed in his book, *A Brief View of the Policy and Resources of the United States* (London, 1810), which quotes Adam Smith's *Wealth of Nations* and also the Malthusian Blodget's *Economica,* to the effect that our numbers are doubled every twenty-three years, since Hale had been Silliman's instructor. In many ways Cooper's views parallel those of Malthus.

[86] *Notions of the Americans* (Phila., 1839), I, p. 14.

[87] *Ibid.,* I, p. 15.

[88] *New York* (New York, 1930), pp. 53–54.

felt that policy would always indicate "its own wants" in the final decision. He was well aware that "the governing motive of commerce, all over the world, is the love of gain,"[89] but he believed the "facts prove that this state of things has many relieving shades" and raises men above "the more sordid vices of covetousness and avarice in detail."[90] Indeed, he thought that "the present advanced condition of the human species" was due to the "conservative principle" which held that " 'they shall get who have the power, and they shall keep who can.' "[91]

It is interesting to notice that Cooper held that "for the improvement of the race and the advancement of truth, it is only necessary to give a man an opportunity to exercise his natural faculties in order to make him a reflecting and, in some degree, an independent being." When applied to his economic theories, as in *The Sea Lions,* this devolved into a belief that unregulated competition was the "wisest" course for providing incentive. Competition, he says, "is the principle that renders the present state of society more healthful and advantageous than that which the friends of the different systems of associatings that are now so much in vogue, wish to substitute in its place." (p. 175). The "political economist" could only succeed "in advancing civilization" by using competition as a "most powerful auxiliary" (p. 175).[92] The same idea had been earlier expressed in *The Prairie* when Natty exclaimed, "might is right, according to the fashions of the 'arth; and what the strong chooses to do, the weak must call justice." (p. 234). This fictional view is more strongly put here than ever Cooper wrote in polemic.

As Cooper came near the end of his writing career his economic ideas changed somewhat, primarily under the influence of Henry C. Carey.[93] Cooper knew Carey personally as his publisher, and together they distrusted the English government and the English landed and commercial aristocracy. With Carey, Cooper approved of the theory that the least possible government restriction upon the individual the better. Carey began his career as a pro-laissez-faire and free-trade man (*The Harmony of Nature,* 1835), but

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[89] *Ibid.,* p. 16.

[90] *Ibid.,* p. 17.

[91] *The Heidenmauer* (New York, 1859–61 ed), p. 279. Cooper became most obtuse in defending Southern "moral improvement" and in denying the commonest dictates of humanity (freeing the slaves), because freeing them would cut down on profits.

[92] Cooper's thought here is sometimes contradictory. While he noted that an aristocrat is "one who is willing to admit of a free competition, in all things" (*The American Democrat,* p. 98), in speaking of free trade he thought it was "set up" by designing Europeans, particularly Englishmen, "to prevent other states from resorting to the same expedients to foster industry." Thus free traders were the "dupes of English sophistry." This idea early expressed was to receive more extended treatment in *The Crater,* where Cooper, following Henry Carey's Newtonian economic views, wrote that the idea of free trade as a means of "humanizing, enlightening, liberalizing, and improving the human race . . . is evil and second only to politics as a corrupter."

[93] On the relation of Cooper's later economic views to those of Henry C. Carey, I am indebted to Harold H. Scudder's article, "Cooper's *The Crater,*" *AL,* XIX (May, 1947), pp. 109–126.

eventually he concluded that the only effective weapon with which other lands might wage war upon the predatory Europeans was a high protective tariff, and that, paradoxically, the only means of achieving free trade was by a policy of protection. These views were not published until 1848, but Carey had undoubtedly reached them in 1847, when Cooper was writing *The Crater*. Here Carey's views find their clearest exposition, the new-sprung islands serving while they remain above water "as a stage upon which he demonstrates that although Carey's economics is sound, man's innate perversity is inescapable."[94]

Actually Cooper's acceptance of Carey's views helped to strengthen the logic of his own position. While he could remain an adamant exponent of individualism in economics as well as in the social and political spheres, he was enabled to hedge it with qualifications which brought his economic theory into line with the qualified individualism in man's other activities and the idea of social gradations associated with the doctrine of the great chain of beings" which he hoped would prevent a rampant, disruptive, anarchy. But if Cooper himself eventually came to oppose complete laissez-faire and squatters (as in the Anti-Rent trilogy), his semi-dramatic presentation of Leatherstocking in *The Prairie* and elsewhere as the spokesman of self-reliant free men scornful of government restrictions, of a laissez-faire doctrine associated with the science of his day, probably did much to make his hero appealing. Thus Leatherstocking tells Middleton that in frontier "America . . . man is left greatly to the following of his own wishes, compared to other countries; and happier, aye, and more manly and more honest too, is he for the privilege! . . . A wicked and a troublesome meddling is that, with the One who has not made his creatures to be herded like oxen. . . . A miserable land must that be where they fetter the mind as well as the body. . . ." This passage is quoted in *The Leatherstocking Saga* (New York, 1954, p. 22) by Allan Nevins, who adds that such a doctrine "has the ring of American denunciation of the totalitarian state" even in 1954.

(Part Two will follow in the next issue of *The Transactions*.)

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[94] Harold H. Scudder, "Cooper's *The Crater*," p. 110. Scudder's thesis is that "Lyell's *Principles of Geology* seems to have been his principle source."

AN ENGLISH SCIENTIST IN AMERICA 130 YEARS BEFORE COLUMBUS

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For thousands of years navigation was almost entirely confined to coast-wise traffic. The sailors of these early years had no compass to tell them in what direction they were sailing nor any astrolabe or sextant to determine their position. About the year 1300 the compass came into use, and some time later also the astrolabe. Then the vast oceans lost most of their terrors and the great age of discovery followed.

The Norsemen did not wait for the discovery of mechanical aids to cross the Atlantic. There was a colony of several thousand Norsemen in Greenland which constituted an entire bishopric, and from the tenth century onward there were many crossings between Norway and Greenland. But aside from this commerce, no sailing from any other country to the western world is reported until in the middle of the fourteenth century. Then we come to an English friar who is said to have spent at least two years in a subarctic part of America.

The name of this friar is doubtful, but Richard Hakluyt who lived 400 years nearer to the friar's time than we do called him Nicholas of Lynn. He was an astronomer who became famous for making an astrolabe which enabled seamen to make fairly accurate observations of the latitude. He made one for John of Gaunt, Duke of Lancaster, who at that time was the principal English patron of the fine arts. Because of this very useful instrument, friar Nicholas was also called The Man with the Astrolabe.

About 1364 he wrote a small book entitled *De Inventione Fortunata* (The Fortunate Discovery). In this he tells of an alleged voyage to an inland ocean which was called *Mare Sugenum* (the indrawing sea), which, if the narrative is true, can only have been Hudson Bay. He presented this book to the King, Edward III. As this was long before the days of printing, the book is now lost, but there are some annotations about it on the margin of old maps made by prominent cartographers and also other references. Richard Hakluyt, the great preserver of early voyages, in 1589 wrote the following report on Nicholas' discoveries as condensed in *The Dictionary of National Biography*.[1]

[1] Vol. 40, p. 418.

> "Hakluyt states that Nicholas of Lynne made a voyage to the lands near the North Pole in or about 1360. His authorities, Gerardus Mercator and John Dee, who make no reference to Nicholas by name, derive their information from James Cnoyen of Bois-le-Duc, a Dutch explorer of uncertain date. Cnoyen's report, written in 'Belgica Lingua,' is lost. Mercator made extracts from it for his own use, and sent them in 1577 to John Dee. These extracts are preserved in the British Museum. From them it appears that Cnoyen's knowledge was obtained from the narrative of 'a priest who had an astrolabe.' This report was presented to the King of Norway in 1364. According to this priest's account, an Oxford Franciscan, who was a good astronomer, made a voyage in 1360 through all the northern regions, and described all the wonders of these islands in a book which he gave to the King of England, and inscribed in Latin *Inventio Fortunata*."

Because of the limited knowledge about Nicholas, historical writers have been cautious in evaluating his achievements. An exception to this is Professor E. G. R. Taylor of the University of London. She calls him "The Outstanding Figure of the Fourteenth Century," in geographical research.[2] Another supporter is B. F. De Costa, the late well known writer on geography.[3] Still another is Jon Duason, a voluminous writer on medieval Icelandic explorations.[4] Ferdinand Columbus and Bartolome de Las Casas are among the early writers who briefly but approvingly mentions Nicholas' book.[5]

Not only was this book, *Inventione Fortunata,* seen by many, but we also have the testimony of Jacob Cnoyen, a Dutch traveler, who in or about 1364 visited Bergen, Norway, where he talked with Ivar Bardson, the *Officialis* of the Greenland bishopric. The latter returned from Greenland in 1364 or the preceding fall in company with Nicholas of Lynn (or whatever was his name) and seven other survivors. Cnoyen writes:[6]

> "The priest who had the astrolabe[7] related to the king of Norway that in A.D. 1360 there had come to these Northern Islands an English Minorite from Oxford who was a good astronomer etc. Leaving the rest of the party who had come to the Islands, he journeyed further through the whole of the North etc, and put into writing all the wonders of those Islands, and gave the King of England this book, which he called in Latin Inventio Fortunatae, which book began at . . . latitude 54°, continuing to the Pole."

This 54th parallel where the narrative starts enters Labrador at Hamilton Inlet. From here he passes on to a sea which is called the

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[2] *Tudor Geography,* 1930, pp. 3, 133. See also her contribution to Arthur P. Newton, *The Great Age of Discovery,* London, 1932, pp. 199–206.

[3] *Journal of the Am. Geo. Soc.* 1880, vol. 12, pp .172, 178, 189.

[4] *Landkönnum og Landnam,* Reykjavik, 1941, pp. 163–74.

[5] Quoted by De Costa, see note 3 above.

[6] Mercator says that he had had a copy of Cnoyen's original report, but later sent it back to its owner. As emended by John Dee, it is interlarded with remarks about King Arthur's imaginary settlement of Greenland in the year 530. Dee's copy is preserved in the British Museum. It is registered as Cotton M.S. Vitellius C. VII. In 1955 I obtained a photostatic copy of it. It has been translated by Professor Taylor and was published in *Imago Mundi,* 1956, XIII, pp. 55–68. The passage quoted above is on pp. 58, 59.

[7] It will be shown below that this refers to Ivar Bardson.

indrawing sea where he found many big islands, swift currents and whirlpools. If he followed the coast northwestward he would come to Hudsoy Bay. It now remains to see if Nicholas' description of the physiographic features in his 'sucking sea' agree with existing details in Hudson Bay.

With this in view I set out on a course of reading everything that had been written about Hudson Bay. But the material proved disappointing. The big encyclopedias, both foreign and domestic, had practically no information about Hudson Bay. While many scientific expeditions have been sent up there, they were practically all interested only in the geology or ornithology of the bay, and Nicholas does not mention these things. A personal visit was considered but rejected because of the great cost. The situation remained unsolved.

Then came good news. In 1957 the Canadian Hydrographic Service published its first Hudson Bay *Coast Pilot,* and after some delay I obtained a copy. In it I found a full description of all its islands, currents, whirlpools, magnetic disturbances, etc., and these are the things that Nicholas dwells on. Let us now see how far Nicholas' descriptions agree with the *Coast Pilot.*

1. The Zugende Zee (the sucking sea), so called because of its swift currents and islands, which, Jacob Cnoyen was told, was the principal field of operations of the priest with the astrolabe, lay beyond, that is, west, of Greenland.[8]

An inspection of the map in Hudson Bay Coast Pilot or any good atlas will show that the only sea which can be called a sucking sea because of its islands and currents is Hudson Bay.

2. Captain George Beste, the historian of the first Frobisher expedition in 1576, wrote the following description of Nicholas' indrawing sea: "As Mercator mentioneth out of a probable author, there was a frier of Oxford who himselfe went verye farre north above 200 years ago. . . . He reporteth that the southwest parte of that lande is a fruitful and a holesome soyle. The northeast parte is inhabited with a people called pygmei, whiche are not at the uttermost above four foote high. . . ."[9]

To understand this description it must be remembered that Nicholas had no other opportunity of observing the land around the sea than what could be seen from the deck of his ship or at a camp on shore. He did not travel by land and knew nothing about the interior of America. Nor did anyone else. When he says that the land to the southwest had a fruitful soil, he means the land on the southwest side of the sea on which he was sailing. Similarly, the pygmies that he saw were on the land northeast of him.

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[8] John Dee's version of Cnoyen narrative in *Imago Mundi,* 1956, p. 57.
[9] V. Stefansson's edition of *The Three Voyages of Martin Frobisher,* Vol. 1, p. 19.

This is true of Hudson Bay. The land on the southwest side of the bay is covered by a vast forest of spruce and tamarack on a front of more than 200 miles; and on the northeast is Baffinland, inhabited only by Eskimo. There is no other sea in the western hemisphere where similar conditions obtain.

3. Mercator quotes Cnoyen as saying that "there is never in these parts so much wind as might be sufficient to drive a cornmill."[10]

This is an exaggeration, but the quietness of the atmosphere in Hudson Bay has been noted by many. *The New International Encyclopedia* says: "Hudson Bay is singularly free from storm or fog." This is also proven by the meteorological tables in the *Coast Pilot* page 328.

4. Cnoyen was also informed that "the Minorite (that is, Nicholas of Lynn) said that large parts of the "indrawing sea" did not freeze over in winter.[11] Johan Ruysch on the margin of his world map of 1508 also says this sea did not freeze in winter.[12]

This is also true of Hudson Bay, which is the only subarctic sea in or near America which is open for the greater part in winter. The *Hudson Bay Coast Pilot* (p. 13) says that the ice in winter "extends off the east coast shore for 60 or 70 miles to include the islands (a long string off the east shore) and the remainder of the bay from one to 5 miles."

5. In Cnoyen's report of what he in 1364 was told about Nicholas' exploration of the sucking sea there is a statement that this sea received many small (?) rivers, some one, some two, and some three *kennings* wide.[13]

Hudson Bay is the only sea in subarctic America receiving any considerable river drainage; but it is a mighty reservoir as it receives the rivers of fully one-fifth of the entire North American area.

6. Most of the quotations from or about Nicholas dwell on the many strong currents in the *Mare Sugenum*. Captain George Beste who in his book, *True Discourse,* published in 1578, shows himself well informed for that period, quotes Mercator's description of the sea visited by the author of *Inventio Fortunata*. He says "it is divided into four partes or Ilandes by foure greate guttes, indrafts, or channels, running violently, and delivering themselves into a monstrous receptacle and swallowing sincke, with such a violent force and currant, that a Shippe beyng entred never so little within one of these foure indrafts, cannot be holden backe by the force of

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[10] See annotation on the margin of Mercator's map of 1569; see also Taylor, *Imago Mundi* XIII, p. 65.

[11] Cnoyen's narrative (fol. 268 v.), printed by E. G. R. Taylor in *Imago Mundi,* p. 60. p. 60.

[12] *Ibid.,* p. 64.

[13] *Ibid.,* p. 57. A kenning was 17–20 miles" (note 6 on same page).

any great winde, but runneth in headlong by that deep swallowing, into the bowels of the earth."[14]

In the northeast corner of Hudson Bay, where its waters meet the waters of Foxe Channel and Hudson Strait, lie four large islands which are constantly pounded by the swift currents of these opposing waters. These are the two Mill Islands and Salisbury and Nottingham. The two Mill Islands were so named by William Baffin in 1615 because of the great grinding of the ice in that vicinity. Mr. Putnam, director of the Putnam expedition in 1937, in an article in the *Geographical Review,* in which he describes the northeastern part of Hudson Bay, wrote: "The fabulously swift tidal currents with their propensity for grinding the ice and swirling it fearsomely hither and yon, are as startling today as then."[15]

7. Nicholas is quoted by Mercator, Heylin and Beste as saying that this sea drains into a gulf with many whirlpools, so difficult to navigate that sailing vessels caught in them cannot get away.

This is a good description of Hudson Strait through which the waters of Hudson Bay reach the Atlantic. The strait has a tide of 35 feet—even 52 feet has been recorded in the Hudson Bay *Coast Pilot,* and when this meets the current from Hudson Bay, the problem of navigating a sailing vessel becomes very serious. If in addition to this a wind is blowing, the situation becomes desperate.

8. This gulf, according to Nicholas, is a hundred miles wide.

While the width of Hudson Strait varies, the usual statement is that it is 100 miles wide.

9. Ruysch, on the margin of his map of 1508, says that in the *Mare Sugenum* "the compasses become useless, and ships that carry iron cannot get away."

The Hudson Bay Coast Pilot (page 263) says that there is so much magnetic disturbance in the northern part of Hudson Bay that "The magnetic compass cannot be relied upon in the approach to Churchill Harbor (on the west coast) in consequence of this magnetic disturbance."

10. Ruysch and Heylin both quote Nicholas as saying that below the arctic pole is "A high mountain of magnetic rock, 33 leagues in circumference, the land adjoining being torn by the sea into four great islands."[16]

The map accompanying the Hudson Bay *Coast Pilot* shows that just west of the four big islands (see number 6 above) stands Mount Minto, a towering rock more than a thousand feet high and in plain view of them. It is now known to be an appendage to Southampton Island, but, according to the *Coast Pilot* (p. 266), was for-

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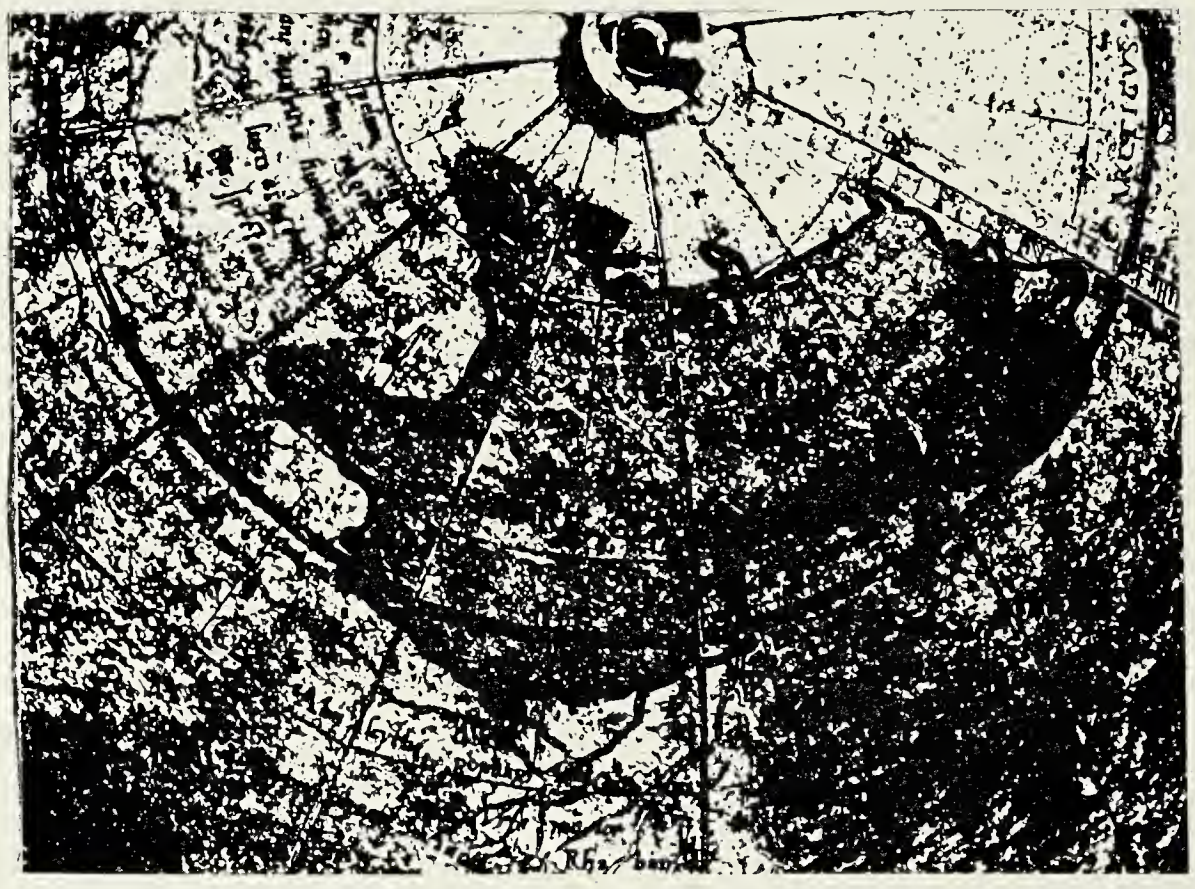
[14] *The Three Voyages of Martin Frobisher,* Stefansson's edition, 1938, Vol. 1, p. 19.
[15] Vol. 18, 1928, p. 10.
[16] Taylor, *Ibid.,* p. 64.



A

B

FIGURE 1. A. Portion of Frisius globe of 1537, with Hudson Bay as *Mare Glaciale*.

B. Modern map of Hudson Bay.

merly thought to be a separate island. It lies close to the area where, according to the *Coast Pilot,* "the compass cannot be relied upon."

With these facts before us, there can be no doubt of Nicholas' voyage to Hudson Bay. Only after personal inspection was it possible to describe the physical circumstances of Hudson Bay as closely as he has done.[17]

There is another probable proof of Nicholas' sojourn in Hudson Bay. About fifty years ago a globe of the world was found in Zerbst, Anhalt, Germany. It was made in 1537 by Gemma Frisius, one of the best cartographers in the Sixteenth Century and was reproduced in part in 1911 in A. A. Björnbo's *Cartographia Greenlandica.*[18] This shows a very good map of Hudson Bay as shown on the accompanying photostat (Figure 1). In the north end we see the opening to Foxe Channel and in the south is James Bay, somewhat too large. On the northeast we see the opening to Hudson Strait. The west coast is almost perfect, with Chesterfield Inlet, Churchill River and the Nelson, all shown in their proper places. There are two rivers having a joint outlet—the Nelson and the Hayes, and this is also shown. It might be objected that this *Mare Glaciale* is pictured as lying in Asia, but how would Frisius know where Asia began? He would only know that this sea lay far northwest of Greenland.

But the critic will object: How would it be possible for Nicholas to make a voyage to America in the 1360's? An exploration of several years' duration would cost a lot of money, and Nicholas, a mendicant monk, certainly had none. Nor was the government interested. Aside from John Cabot's voyage in 1497, it was about 250 years before the English became interested in America.

This is quite true, but there was an expedition in American waters at that time, and it spent about two years, 1362 and 1363, in Hudson Bay. This was a royal expedition, initiated and financed by Magnus Erikson, King of Norway and Sweden. It was fitted out with great care, and Sir Paul Knutson, one of the leading noblemen of Norway, was appointed Commodore. *We have four different reports* or channels of information about this expedition. It was not primarily an exploring enterprise, but a crusading endeavor to bring a large group of Norse Greenlanders back into the Church.

THE FIRST REPORT is the historical record of the cause and purpose of the expedition. It gives the King's commission to Sir

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[17] This was emphasized in 1577 by Captain George Beste in the following words: "This so particular a description of the land and countries lying about the Pole, argueth that this Oxford frier tooke great pains therein, and induceth great probabilities and likelihood of the truth thereof, because he observed so diligently by measure, the bredth of the indrafts, what time, and how long they continued frozen, and with how manye mouths or receipts every one of them received the ocean." *The Three Voyages of Martin Frobisher,* publications of the Hakluyt Society, Ed. of 1867, Vol. 38, pp. 34 ff.

[18] See *Meddelelser om Grönland,* Vol. 48, Plate 4.

Paul to find a certain group of Greenland people who were reported to have given up the true faith and emigrated to parts unknown. These people lived in what was known as the Western Settlement. This was about 250 miles northwest of the main settlement in Greenland.

In 1342 these people disappeared. We have the report of a prominent man who visited this settlement in that year and found that the entire population had vanished. He was Ivar Bardson, the steward of all the large properties of the Church in Greenland. There is also a late copy of an Icelandic Annal, stating that the people in the Western Settlement had given up the Christian faith and in 1342 had emigrated to America.[19]

As Greenland was a crown colony and private trading was strictly forbidden, these people were entirely dependent upon the King for all their imports. He had neglected both their temporal and spiritual welfare. Eventually he learned of their miserable condition many years later and then, full of self-reproach, he sent a very strongly worded letter to Sir Paul providing for a relief expedition. The following is a translation of a sixteenth century copy of the letter.

> "Magnus, by the grace of God, King of Norway, Sweden and Skaane, sends to all men who see or hear this letter good health and happiness.
>
> "We desire to make known that you [Paul Knutson] are to select the men who shall go in the Knorr . . . from among my bodyguard and also from among the retainers of other men whom you may wish to take on the voyage, and that Paul Knutson the commandant shall have full authority to select such men whom he thinks are best qualified to accompany him whether as officers or men. We ask that you accept this our command with a right good will for the cause, inasmuch as we do it for the honor of God and *for the sake of our soul* and for the sake of our predecessors, who in Greenland established Christianity and have maintained it to this time and *we will not let it perish in our days.* Know this for truth, that whoever defies this our command shall meet with our serious displeasure and thereupon receive full punishment."
>
> "Executed in Bergen, Monday after Simon and Judah's day in the six and XXX year of our rule (1354) by Orm Ostenson, our regent. Sealed."[20]

The reader will note that this was not a commercial but a military rescue party, requiring a select body of trained men.

As Sir Paul's commission is dated October 27, 1354, the expedition could not have started until the summer of 1355. However, the Icelandic Annals for that year report that 1355 was so excessively stormy that no ship arrived in Iceland or left in that year. The earliest possible date for the departure of the expedition would therefore be 1356. It will be shown below that Ivar Bardson, the

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[19] P. A. Munch, *Unionsperioden,* Vol. 1, p. 314; Grönlands *Historiske Mindes.* III, 259.

[20] See *Grönlands Historiske Mindesmerker* III, 120–122; Gustav Storm, *Studier over Vinlandsreiserne,* 1888, p. 73; H. R. Holand, *Westward From Vinland,* 1940, pp. 90, 91.

bishopric's *officialis,* returned to Bergen in 1364, bringing with him eight survivors of the expedition. There is no explicit mention of the return in Norwegian records. For this reason some critics have doubted that it ever set out.

But there is plenty of evidence that it took place and in part returned. There is first of all the compelling need of it. Greenland was a crown colony and therefore under the immediate supervision of the King himself. He had failed in this, and, being a very pious man, he eventually realized his guilt most keenly. For this reason he writes in his letter that he was sending this expedition "for the sake of our soul." As he felt that his salvation depended on his effort to rescue these lost Greenlanders, it is not likely that he would neglect to do so, providing he could find the money that was needed in fitting out the expedition.

This was fortunately in his possession. In 1351 he had sent a delegation to the Pope, requesting a big loan to be used in his campaign against the heretical Russians. The Pope approved his request and ordered that a holy crusade be preached in Germany and Poland as well as in the Scandinavian countries. The King was also permitted to retain half of the tithes collected in Norway and Sweden during the four years from 1352 to 1356.[21] As the King was obliged to give up his third campaign against Russia because his men refused to expose themselves to a third attack of the Black Death (the Asiatic cholera), he had sufficient funds for his expedition to Greenland and the West.

Concerning the purpose and time of return of this expedition, Professor Gustav Storm, in his time an expert on old Norwegian history, says:

> "The object of this expedition is said to be to maintain Christianity in Greenland, i.e. a battle with the Eskimo, including an effort to strengthen the colony generally, perhaps also to explore the new lands. One thing is sure that the conditions of the colony and its fate were thoroughly considered in Bergen whence the expedition departed, and to which it returned after a number of years, most likely in 1363 or 1364."[22]

We have further information about this expedition is a statement by Archbishop Claus Magnus. He writes:[23]

> "In the year 1505 I personally saw two skinboats above the western entrance within the cathedral dedicated to the sainted Halward. . . . It is stated that King Haakon captured them when he with his battle fleet passed the coast of Greenland. . . ."[24]

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[21] P. A. Munch, *Unionsperioden,* Vol. 1, pp. 535, 536.

[22] *Studier over Vinlandsreiserne,* 1888, pp. 73–74. See also A. A. Björnbo, *Cartographia Groenlandica,* 1910, p. 14; A. Steinnes in *Syn og Segn,* 1958, pp. 7–8; J. Duason, *Landkönnum,* 1941, 163–174.

[23] *Historia de gentibus septentrionalibus,* Rome, 1555, Book II, Chap. 9.

[24] While the expedition was planned by King Magnus in 1354, it was carried out by King Haakon, who succeeded his father in August, 1355.

Manifestly, the capture by a battle fleet of two small one-man skin-boats was not such an outstanding victory that the prize was given a place of honor in a cathedral! But if they were the only mementos of the men who had sacrificed their lives in their effort to save their humble countrymen from eternal damnation, we can see that their presence in the cathedral was a well deserved honor. And there they hung for generation after generation to testify to the self-sacrifice of these men.

At this time (the middle of the Fourteenth Century) there was much interest in the western lands. In 1347 a company of Greenlanders went to Markland to get a cargo of timber. Markland was the Norse name for Nova Scotia and possibly New-Foundland. On their return voyage they were storm-driven to Iceland, and thus their voyage became recorded.[25] A few years before that event Sir Hauk Erlendsson, who was Sir Paul's immediate predecessor as Judge of Gulathing, had written a book about the Norse discoveries in America which is still a basic document.[26] As both of these men lived in Bergen, and in view of Sir Paul's appointment as commodore of this new expedition, he no doubt studied Sir Hauk's book with care. In this he would learn much about Vinland, a very pleasing place, where grapes grew in abundance. Most commentators agree that Vinland lay in the southern part of New England. Here, probably, Sir Paul built a fortified base where crops could be grown while subdivisions searched the shores for signs of the Greenland apostates, which might take several years.

It is not likely that the search went southward very far, because a people accustomed to the climate of Greenland would not care for the hot weather of the south. But northward the prospect was more promising. And when Sir Paul's men got far north to Hamilton Inlet and beyond, where the climate was like that of Greenland, they would have good hopes of succeeding in their search. This coastwise passage would lead them into Hudson Bay, unless the exiles were found before going so far.

We thus see that the royal expedition had good reason for being in Hudson Bay early in the 1360's. And they were there at the same time as Nicholas, because he and the survivors of the royal expedition returned to Greenland in 1363, and in 1364 they arrived in Norway, as will be shown below. It is beyond belief that there were two independent expeditions in that remote part of America and at exactly the same time. The only reasonable conclusion is that Nicholas was a member of the royal expedition.

But is it likely that an Englishman would be a member of a Swedish-Norwegian expedition?

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[25] *Islandske Annaler*, Storm's Ed., of 1888, pp. 213, 353, 403.

[26] The title is *Hauksbok;* A. M. Reeves, *The Finding of Vinland the Good*, London 1895, contains photographic reproductions of the text.

The knowledge of geography in the Middle Ages was so scant that all countries interested in exploration were glad to avail themselves of foreign experts. Spain's greatest progress was made by help of three foreign navigators—Columbus, Vespucci and Magellan. The first French voyage to America was guided by Verrazano, a Florentine, and the first English vessel sent into the West was commanded by John Cabot, a Venetian. Lynn in Norfolk, England, was the principal port of Norwegian trade in England and many Norwegians lived there.[27] There was therefore brisk intercourse between Lynn and Bergen, from which port the royal expedition set out. Moreover, Gisbrikt, the Bishop of Bergen, was an Englishman, and he was no doubt deeply interested in the success of this great religious enterprise to an unknown country. He would therefore urge upon Sir Paul, who also lived in Bergen, the wisdom of securing the service of his famous countrymen, 'the man with the astrolabe.'

Below we shall see that the royal expedition not only operated in the same remote part of America, but that it was there at exactly the same time and returned to Bergen the same year.

THE SECOND REPORT. This is Nicholas' report in *Inventione Fortunata* as preserved in the fragments cited above. The original probably told of how he reached America.

THE THIRD REPORT is Jacob Cnoyen's interview with the priest, Ivar Bardson, in 1364 as preserved in the British Museum papers. For fifteen years the latter had waited in Greenland for a ship so he could return to Norway and report that the Greenland bishop was dead. Finally in 1363 Nicholas returned to Greenland with seven survivors (see below), and the next year he brought them with Ivar to Norway.[28]

When Jacob Cnoyen came to Bergen, Nicholas had probably left for England because Cnoyen does not say he had spoken with the Englishman. Cnoyen made a report of what he had learned about Nicholas' great voyage, but as much of this dealt with things and places he had never heard of, it is not strange if his narrative is sometimes incomprehensible. For instance, he reports that Nicholas had seen a black magnetic mountain right at the North Pole.

This plainly shows that Nicholas had been misunderstood. Johan Ruysch (1508), quoting from Nicholas' book, placed the Sucking Sea with its magnetic mountain about 1500 miles from the Pole (see his World Map of 1508 in the Rome Ptolemy).

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[27] Alexander Bugge, "Handelen mellem Norge og England," *Historisk Tidskrift*, Oslo, 1896.

[28] We know that Ivar Bardson was in Bergen in 1364 because he was then appointed Canon of the Church of the Apostles in Bergen, the most important of the fourteen royal chapels. See *Diplomatarium Norwegicum*, IV, p. 341,

As Nicholas had an astrolabe by which he could check the direction in which the compass needle pointed, he was the first to discover that the needle diverges farther and farther from true north as one travels northward along the eastern coast of North America. But to the people in Europe this was all incomprehensible. To them the identity of the magnetic pole with the arctic pole was an inherited and undebatable conclusion without any dissenters. That is why the cartographers for 200 years afterward continued to place Nicholas' magnetic mountain at the North Pole.

This black magnetic mountain was probably Mount Minto, 1060 feet high, in the northern part of the bay, which can be seen from all the surrounding islands. Nicholas may have thought of it as a magnetic center because it prevented further search for the magnetic pole. It stands off the northeastern point of Southampton Island which extends southward and westward for 200 miles. Nor could he push northwestward by ship because the *Coast Pilot* says that "the steep northeastern coast [of this island] is practically always blocked with ice from Foxe Channel." (P. 265).

Cnoyen mentions the survivors of the expedition three times:

> "Anno Domini 1364 came 8 of these persons to Norway to the King. Among them were two clerics. One of them had an astrolabe who in the fifth generation was descended from Brusselites. These 8 were of the original party who had penetrated into the northern regions."[29]

On the next page there is a similar but somewhat different statement:

> "The priest who had the astrolabe told the King of Norway that a Minorite from Oxford who was a good astronomer had come into these northern islands in 1360. He separated from the others who had come . . . and wrote about all the remarkable things among these islands in a book which he gave to the King of England which he in Latin called *Inventio Fortunatae*. This book begins at the last climate, that is to say from latitude 54, and goes up to the Pole."[30]

Here we find that while the astrolabe was first exhibited by Nicholas, it later came into the temporary possession of Ivar Bardson in exchange for a testament. Later Cnoyen says that when Nicholas left Norway, he gave the astrolabe to his seven shipmates. Cnoyen writes that Ivar, in repeating what Nicholas had told about a magnetic mountain, says:

> "And it is so high (so the priest said) that his people, who had received the astrolabe as a gift from the Minorite, had told him, and that he had himself heard the Minorite say, that the mountain was visible from the shore of the sea" etc. (page 268 recto).

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[29] Brit. Mus. M. S. Ott. Vitell. C. VII, 264–268. Now translated and published by E. G. R. Taylor in *Imago Mundi*, 1957.

[30] *Ibid.* 266 verso and recto.

By this we see that Nicholas was not alone nor did he travel by his "Magicall Arts" as Mercator says a dozen pages back. He must, of course, have had a ship and some men. And this ship was manned by Norwegian men of whom seven survived and returned to Bergen with Nicholas and Ivar. In other words, they were members of the royal expedition, and Nicholas was its astronomer and navigator.

THE FOURTH REPORT tells of what happened to the larger part of the divided expedition. This is told on the Kensington Stone, concerning which there has been much dispute. This stone was found in the Fall of 1898 by a recent immigrant from Sweden while clearing a tract of primeval timber land. It contains a long inscription in runic characters. Copies of the inscription were sent to scholars in the University of Minnesota, Northwestern University, and the University in Oslo, but none of the scholars in these institutions were able to transliterate the entire inscription. It was therefore rejected on philological grounds as "a clumsy forgery," and the stone was forgotten. Nine years later the inscription was correctly translated, but by that time it had a bad reputation, and those who had rejected the inscription without knowing its contents continued their opposition.[31]

The following is a transliteration of the inscription. To save time and labor, the runemaster omitted all the words that could be omitted without impairing the sense of the message. These omissions are supplied in parenthesis:

> *(We are) 8 Goths and 22 Norwegians on (an) exploration voyage from Vinland through the West We had camp by (a lake with) 2 skerries one day-voyage north from this stone We were (out) and fished one day After we came home (we) found 10 (of our) men red with blood and dead AV(E) M(ARIA) save (us) from evil*
>
> *(We) have 10 of (our men) by the sea to look after our ships 14 day-voyages from this island (In the) year (of our Lord) 1362*

This inscription parallels the Nicholas narrative. He is reported to have said that he in the year 1360 began his research among the northern islands at latitude 54°. This parallel enters Labrador at Hamilton Inlet. As this place loomed so big in his mind, he no doubt found something here of special interest. This apparently was the big variation of the compass. When he took his observation and checked his compass he would find that the needle did not point north but northwest. It showed a variation of 38 degrees

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[31] The principal presentations of the arguments pro and con the authenticity of the inscription are, in the order in which they appeared in print, H. R. Holand, *Westward From Vinland,* 1940, pp. 87–215; S. N. Hagen, *Speculum*, 1950, pp. 311–356; Johannes Brönsted, *Aarbog for Nordisk Oldk. og Historie,* Copenhagen, 1950, pp. 64–152; Wm. Thalbitzer, *Smithsonian Miscellaneous Publications,* 1951, Vol. 116, No. 3, 1–71; and Erik Wahlgren, *The Kensington Stone,* 1958.

from north! No doubt he made many observations in the vicinity to see if a local magnetic center caused this great aberration, because if it did not, then the magnetic pole was not at the north pole, but more than a thousand miles below it! This was a great discovery indeed, and explains the title of his book, *De Inventione Fortunata:* It was a fortunate discovery indeed to find that the magnetic pole was far from the North Pole.

The men who left the Kensington were also at Hamilton Inlet in 1360, because they arrived in Hudson Bay in the Fall of 1361. Hamilton Inlet is more than a hundred miles long with a shore line of about three hundred miles, with plenty of timber for fuel and housebuilding and also good fishing and hunting. It would therefore seem an ideal place, in which to look for the lost Greenlanders. As Hudson Strait is navigable for sailing vessels less than four months in the year, it seems fairly certain that the search party spent the winter of 1360–1361 somewhere on Hamilton Inlet. The summer of 1361 would be needed to bring the expedition to Hudson Bay, where we find it in 1362.

Is there any evidence that the men who left the Kensington Stone visited Hudson Bay? Yes, the inscription says they came from *the north,* from an ocean (*havet*), which they estimated was about a thousand miles from the finding place of the stone. This is approximately correct.[32]

Nicholas reports that after he arrived in Hudson Bay, the expedition of which he was a member divided in two, but he does not say why this was done.

This is explained, however, on the inscribed stone which says that out of the total number of thirty, twenty men decided to go inland, "leaving ten to stay by the ships." This is corroborated by Nicholas who is quoted as saying that after the expedition divided he had abundant opportunity to make extensive explorations. Ten men were left with the ships in Hudson Bay, but when he returned to Bergen he had only eight survivors including himself. This is what might be expected, because Hudson Bay is a cruel place in which to spend the winter. Nicholas was fortunate in losing only two.

The Kensington inscription says that this division took place in 1362, and this agrees with Nicholas' schedule because in 1363 he made the voyage to Greenland, about two thousands miles away.

Thus we see that the Kensington inscription is not an isolated freak without historical connection, but reports a tragic climax in

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[32] The distance is given as "14 day-voyages." This was a nautical unit of distance originally based on the length of an average day's sail—about 75 English miles. These men did not do much sailing, but arrived at each unit by dead reckoning. See Wm. Hovgaard, *Voyages of The Northmen,* 1914, and G. M. Gathorne-Hardy, *Norse Discovery of America,* 1921.

one of the world's greatest exploration expeditions. It is one of four reports about King Magnus' royal expedition, but viewed from different viewpoints. To the remorseful King and the Commandant it was an earnest endeavor to save the souls of the neglected Greenlanders from eternal damnation. To the scientist, Nicholas of Lynn, it was a grand achievement in the fields of navigation, magnetic attraction and geography. While to the adventurous young men who went inland

"For to admire and for to see,
For to behold this world of ours,"

it was a venture into a land of romance which ended in a staggering tragedy. But with staunch fortitude they inscribed their story on a stone so that later travelers might know of their earlier presence.

With these facts before us we can now make the following summary:

1. The Kensington Stone tells of a voyage to Hudson Bay in the early 1360's. The Nicholas of Lynn report also tells of a voyage to Hudson Bay at this time.

2. After arriving in Hudson Bay the Norse expedition divided in two, the larger number (20) going inland, leaving ten men to take care of the ships. The Nicholas narrative also says that the company divided after reaching Hudson Bay.

3. According to the Kensington Stone, this division took place in 1362. The Nicholas report does not give the year, but, as shown above, it must have been in 1362.

4. The twenty men who went inland met with disaster and none returned. Evidently the group that parted company with Nicholas also came to grief because in 1363 when he returned to Greenland he had only seven survivors besides himself.

5. The Kensingtone Stone is a record of a Norse exploration (eight Goths and twenty-two Norwegians). Nicholas' party were also Norsemen because all his seven surviving companions returned to Norway, not England.

6. Professor Storm says that the royal expedition returned to Bergen in 1363 or 1364 (see note 22, above). According to Jacob Cnoyen this was the same time and place when the survivors of the Nicholas of Lynn returned.

The above identifications prove that these three narratives all deal with the same expedition.

S. T. COLERIDGE: HIS THEORY OF KNOWLEDGE*

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"The first step to knowledge, or rather the previous condition of all insight into truth, is to dare commune with our very and permanent self." *Inquiring Spirit*

As such scholars like Alice D. Snyder and Kathleen Coburn have suggested, Samuel Taylor Coleridge throughout his life was extraordinarily conscious of man thinking, and especially of himself thinking.[1] Coleridge lived in an age which had read Descartes, Locke and Hume. He, himself, had also read Kant and other German philosophers. So his preoccupation with mental processes is not unusual. But Coleridge consistently attempted to avoid the pitfalls involved in a subjective approach to knowledge, and therefore tried to establish objective truth and an objective universe which could be known by the human mind. Nevertheless, although Coleridge felt he had re-established man in a cognizable and infinite universe, this construction was achieved, ironically, only through a more intense brand of subjectivity. Although, too, this search was undoubtedly carried on by great eclecticism in terminology and thought, Coleridge's philosophic merits, as J. H. Muirhead insists, should be judged apart from philosophers like Kant.[2] Coleridge pretended to synthetic originality, and we must, at least initially, take him at his word.

In order to understand the search Coleridge made for the knowable, it is necessary that Coleridge himself be understood—insofar

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[1] Alice D. Snyder emphasizes this aspect of Coleridge's thought when she says, ". . . no one . . . can question the fact that he [Coleridge] took keen delight in the process of thinking, irrespective of the end toward which it was directed." *Coleridge on Logic and Learning* (New Haven, 1929), p. 11. Further citations from Coleridge's work on logic will be to Alice D. Snyder, *Coleridge on Logic and Learning* (New Haven, 1929). Kathleen Coburn also emphasizes Coleridge's "psychological approach to all human problems." *Inquiring Spirit* (London, 1951), p. 15.

[2] René Wellek has demonstrated Coleridge's relation to Kant and other German philosophers in *Immanuel Kant in England* (Princeton, 1931). He does, however, "insist on a fundamental lack of real philosophical individuality in Coleridge, whether his thought was fragmentary or not," p. 66. He goes on to say, "Already *The Friend* shows everywhere how Kant's teaching has become central for Coleridge's thought. One wonders how even quite recently in J. H. Muirhead's *Coleridge as Philosopher* it ever could have been denied, that Kantian thought is determining the essentials of Coleridge's theoretical doctrines and coloring even the minutest tags of his terminology," p. 102. J. H. Muirhead, on the other hand, had felt that Coleridge erected a "far more coherent body of philosophical thought than he has been anywhere credited with." *Coleridge as Philosopher* (London, 1930), p. 15. This opinion he reasserted in a later article contradicting Wellek: "Metaphysician or Mystic," in *Coleridge Studies by Several Hands on the Hundredth Anniversay of his Death*, ed. Edmund Blunden and Earl L. Griggs (London, 1934), pp. 179–197.

as that known was developed through conscious self-probing. Early in his philosophical thinking Coleridge said of himself: "If one thought leads to another, so often does it blot out another. . . . The first thought leads me on indeed to new ones; but nothing but the faint memory of having had these remains of the other, which had been even more interesting to me . . . my thoughts crowd each other to death" (*Anima Poetae,* p. 189).[3] Thus, too much existed in the mind of Coleridge—too many thoughts, too many ideas, and no real progression or logical order. We have only to read through the *Anima Poetae,* or the *Biographia Literaria* to see the chaos as well as the flash of brilliance.

Because of Coleridge's sense of mental chaos, perhaps, he felt a profound distrust of mere feeling and involuted thought as a means toward knowledge. Such distrust is found again and again throughout his writings. In the *Anima Poetae* Coleridge specifically denied validity to all those feelings that the mind believed, wrongly, to constitute objective knowledge. He named this process the "thinking disease," and characterized it as morbid and essentially futile.[4] Later in the *Aids to Reflection* and *The Friend,* Coleridge again insisted that feelings, emotions or moods were wholly delusive, for the mind objectified feeling and emotionally falsified the object. "The shapes of the recent dream [he said] become a mould for the objects in the distance, and these again give an outwardness and sensation of reality to the shapings of the dream" (*Aids to Reflection,* p. 131).[5]

Coleridge then identifies this falsifying nature of the emotions with the mystic's intuitions, which he thinks equally delusive. In the poet's language of moonlight and shadow, he describes the mystical fantasy as it "spreads its soft shadowy charm over all, conceals distances, and magnifies heights, and modifies relations; and fills up vacuities with its own whiteness, counterfeiting substance" (*Aids to Reflection,* p. 355). But Coleridge applies similar imagery indiscriminately throughout his writings to what he considers false perceptions of knowledge. So his concept of pernicious and idle dreaming is blurred with his concept of the mystical experience, just as it is also blurred with what he thinks is blind sense perception. This use of imagery, I believe, although Muirhead would perhaps have disagreed in part, ultimately confuses the distinctions between kinds of false knowledge, and may finally assist to obscure Coleridge's categories of true knowledge.[6]

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[3] Citations from the *Anima Poetae* in my text are to Samuel Taylor Coleridge, *Anima Poetae,* ed. E. H. Coleridge (London, 1895).

[4] pp. 169–70.

[5] Citations from the *Aids to Reflection, The Friend,* and *The Statesman's Manual* in my text are to Samuel Taylor Coleridge, *The Complete Works,* ed. E. H. Coleridge (London, 1895).

[6] Muirhead said that ". . . the exuberance of his language and the vividness of his imagery were too apt to run away with him, and to lead to his frequent failure to

Nevertheless, Coleridge thought it necessary to establish the value of the mind's functionings. In 1811, again using his own mind as a basis, Coleridge was already questioning the relationship between thought and objective truth.[7] The most obvious object for thought is, of course, the external world. But Coleridge, following British empiricism and later Kant's distinction between phenomena and noumena, felt that the external world could be perceived only as a series of sense impressions which possess no more than subjective reality. In *The Friend,* Coleridge says man discovers "that the reality, the objective truth, of the objects he has been adoring, derives its whole and sole evidence from an obscure sensation, which he is alike unable to resist or comprehend . . ." (p. 460).[8] Coleridge extends this familiar concept of the subjective nature of sensory perceptions into a strained theory of history. Since he feels that man individually represents the cumulative history of man generically, Coleridge believes that one individual mind's progress towards knowledge is a repetition of the whole span of history. Man, before the rise of Greek civilization, depended entirely upon knowledge which falsely attributed objective validity to things perceived by the senses. This subjectivism is morally judged and condemned as depraved.[9] Thus, both individually and collectively, man is forced by experience itself to acknowledge the inadequacy of experience as a criterion of truth. Not only is experience finally subjective, but, if it is believed to be objectively valid, it also leads to self-destruction.

Coleridge, however, could not accept the possibility that no criterion of objective knowledge existed, and positively rejected such a consideration. His inability to accept a system like Hume's, or even chaos as fact, he found itself a negative proof of order and truth. Coleridge felt that the need to believe exists as an essential part of man's being, and in this need, I think, he grounded the basis of his whole epistemological attempt.[10] Furthermore, this

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distinguish between metaphor and argument," p. 258. But the difficulty, I think, in Coleridge's use of language is not only to be found in the mental leap the reader must make between what is rationally argued and what is emotionally felt through poetic image, but also in Coleridge's practice of using similar or identical imagery to describe separate categories of thought processes. Compare also *The Friend,* pp. 134–6.

[7] *Anima Poetae,* pp. 245–6. Here Coleridge saw chaos as the only alternative to order existing in the mind and its perception of reality.

[8] See also *The Friend,* p. 444. Coleridge said that both Plato and Bacon "saw that there could be no hope of any fruitful and secure method, while forms, merely subjective, were presumed as the true and proper moulds of objective truth."

[9] "Those . . . who determined to shape their convictions and deduce their knowledge from without, by exclusive observation of outward and sensible things as the only realities, became, it appears, rapidly civilized. . . . They became the great masters of the agreeable, which fraternized readily with cruelty and rapacity; these being, indeed, but alternate moods of the same sensual selfishness," *The Friend,* p. 453. See also the *Treatise on Method,* p. 48. Citations to the *Treatise on Method* in my text are to *S. T. Coleridge's Treatise on Method,* ed. Alice D. Snyder (London, 1934).

[10] René Wellek insists that Coleridge's philosophy is split into an unreconciled dualism of faith and logic. I feel, rather, that Coleridge occasionally attempted to build a logical superstructure upon what is not so much "faith" as it is the need for a faith,

need to believe may explain much of the tortured logic to be found in his epistemology. It is expressed, through metaphor as usual, in the *Aids to Reflection:* "And shall man alone stoop? Shall his pursuits and desires, the reflections of his inward life, be like the reflected image of a tree on the edge of a pool, that grows downward, and seeks a mock heaven in the unstable element beneath it, in neighborhood with the slim water-weeds and oozy bottom-grass that are better than itself and more noble, in as far as substances that appear as shadows are preferable to shadows mistaken for substance. No!" (p. 181).

In *The Friend,* Coleridge calls the need to believe "instinct." It is true categorically, this *desiderium* of the mind, as is its object: "In a self-conscious and thence reflecting being, no instinct can exist without engendering the belief of an object corresponding to it, either present or future, real or capable of being realized" (p. 449). Even though Coleridge never reconciled this concept with his distrust either of sense perceptions or feelings, he did believe, nevertheless, that instincts exist in the mind innately and point towards knowledge. Thus instinct becomes a force impelling man to delve through appearance to reality. As he later said in the *Treatise on Method,* instinct is "a Pursuit after unity of principle, through a diversity of forms" (p. 24).[11] This appetency is directed in a distinctly Kantian way toward the Laws underlying and governing the superficial objects of sense. Because of the direction taken by instinct, Coleridge saw this faculty as the precursor of the mind's Ideas. These Ideas are also innate, although not all minds possess identical Ideas. They are true absolutely, and are the mental counterparts of those Ideas which, given form in nature, constitute Laws.[12]

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and that, as Muirhead said, logic is confined to the realm of the Understanding, not the Reason. Wellek, pp. 69, 81. Muirhead, pp. 67–8. Coleridge said, early in *The Friend,* "But what are my metaphysics?—Merely the referring of the mind to its own consciousness for truths indispensable to its own happiness!" p. 103. See also *The Friend,* p. 459. .

[11] Often instinct is defined in purely poetic terms: "*instinct,* a vague appetency towards something which the Mind incessantly hunts for, but cannot find, like a name which has escaped our recollection, or the impulse which fills the young Poet's eye with tears, he knows not why." *Treatise on Method,* p. 6.

[12] J. H. Muirhead strongly denies that Coleridge relied on the doctrine of innate ideas, and defines the Coleridgean ideas, which "rise in the mind, as something which is neither merely given from without nor as something merely imposed from within, but as something in which outer and inner are united, deep calling to deep, in the self-evolution of truth," p. 102. In *The Friend* Coleridge explains his conception of ideas: ". . . idea and law are the subjective and objective poles of the same magnet, that is, of the same living and energizing reason. What an idea is in the subject, that is, in the mind, is a law in the object, that is, in nature," footnote, pp. 449–50. But, later in this same essay Coleridge emphasizes that man "discovers and recoils from the discovery, that the reality, the objective truth, of the objects he has been adoring, derives its whole and sole evidence from an obscure sensation, which he is alike unable to resist or to comprehend, which compels him to contemplate as without and independent of himself what yet he could not contemplate at all, were it not a modification of his own being," p. 460. Coleridge says again in *The Friend,* "In order therefore to the recognition of himself in nature man must first learn to comprehend nature in himself, and its laws in the ground of his own existence. Then only can he reduce

Coleridge understood nature to be a continuum of life which follows certain Laws and tends towards one particular end. Following the developmental theories current at the time, Coleridge believed that the Law of evolution involves constant individuation.[13] Along with the tendency of nature to individuate is an opposing tendency towards unification, since Coleridge thought that the individuation of members within a particular kind involves a more intense unification.[14] Man himself stands at the apex of nature, and thus exemplifies most fully the combined process of individuation and further unification. "In Man the centripetal and individualizing tendency of all Nature is itself concentrated and individualized—he is a revelation of Nature!" ("Appendix C," *Aids to Reflection,* p. 412).

Because man heads and fulfills nature's processes, Coleridge thought, man can recognize the Laws of nature most fully within himself. Since man partakes of these Laws, he knows them to be true. Thus man is able to "recognize in her [nature's] endless forms, the thousandfold realization of those simple and majestic laws, which yet in their absoluteness can be discovered only in the recesses of his own spirit" ("Appendix C," *Aids to Reflection,* p. 396). Such an analysis of the correspondence between man and nature is, of course, an attempt to establish order within the natural universe, and is as much akin to Hooker as it will be to Darwin. But Coleridge slips away from both with his only half-admitted theory of innate Ideas, which he wanted to exist absolutely as well as subjectively in man's mind, and which he also seems to have seen as Laws working themselves out materially in man himself. Nor indeed did Coleridge successfully bridge the gap between nature and the mind of man, for he finally took refuge in the subjective intuition of this truth described through metaphor.[15]

Coleridge's concept of the natural universe and the means towards its knowledge becomes complicated in his theory of method—and without method, he found only chaos.[16] The principle of method presupposes a progression of thought within the mind which synthesizes Ideas, presumably in the same way Laws work themselves out in nature. The active mind thus parallels the functioning of the material universe and, in so doing, organizes what nature super-

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phaenomena to principles . . . ," p. 462. Ideas, then, would seem to be necessarily innate, even though they correspond to laws in nature. See also *Treatise on Method,* pp. 5–10; *Logic,* pp. 135–7. In the *Aids to Reflection,* Coleridge identifies the law with the will, insofar as it works itself out in nature, "In irrational agents, namely, the brute animals, the will is hidden or absorbed in the law. The law is their nature," p. 296.

[13] "Appendix C," *Aids to Reflection,* p. 391.

[14] "Appendix C," *Aids to Reflection,* p. 388. Muirhead sees Coleridge's theory of life principally in terms of individuation, rather than both individuation and reunification, pp. 127–130.

[15] See *The Friend,* pp. 462–464.

[16] See *Treatise on Method,* p. 3.

ficially does not, to establish immutable knowledge. Rather poetically, Coleridge says that the man of method "organizes the hours, and gives them a soul: and to that, the very essence of which is to fleet, and *to have been,* he communicates an imperishable and a spiritual nature" (*Treatise on Method,* p. 13).

But Coleridge's concept of method, where the mind constructs "unity in progression" and thus achieves permanency by ordering, became further complicated in what seems to be an extension of his theory of trichotomy.[17] The processes of life had been defined in terms resembling the logical "Identity, Thesis, Anthesis." Coleridge then defined life dynamically as force and change. "Life itself is not a *thing*—a self-subsistent *hypostasis*—but an *act* and *process*" ("Appendix C," *Aids to Reflection,* p. 416). Life is the oscillation between the forces of individuation and those of unification. The flux, therefore, that Coleridge wanted so intensely to organize and perhaps stop became the prerequisite for order.[18]

The mind's knowledge of this process is dynamic, and knowledge, too, is identified with force. In his schematic work on logic, Coleridge said, "I regard that alone as genuine *knowledge* which, sooner or later, will reappear as *power*" (*Coleridge on Logic and Learning,* p. 73). Coleridge also developed this concept in *The Statesman's Manual.* There he said that the man of Ideas will "receive the spirit and credentials of a lawgiver," and that the "power of an idea" is "the one lawful qualification of all dominion in the world of the senses" (p. 445). However, Coleridge did not correlate his concept of knowledge as power with the knowledge of nature or with his theory of life, nor, as ever, was there any real attempt to correlate the three. The knowledge so obtained is to be understood merely as the power to act in some commanding way towards man and nature, or is described generally in the metaphor that defeats itself by its very scope.

Up to this point in my argument, of course, I have been concerned primarily with that knowledge given by or peculiar to what Coleridge called the Understanding. Coleridge defined the Understanding many times over in *The Friend* and the *Aids to Reflection,* and René Wellek among others has pointed out Coleridge's dependence upon Kant's description of the Understanding.[19] It is, simply, that faculty through which knowledge of the external world is received. Furthemore, just as the Understanding is not passive

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[17] Muirhead discusses Coleridge's theory of trichotomy, and defines it as a kind of logic where opposites are forms of a single, higher, unity, pp. 82–8. The terms he uses are Coleridge's: "Identity, Thesis, Anthesis."

[18] See also "Appendix C," *Aids to Reflection,* p. 392.

[19] René Wellek, pp. 103–4. Muirhead, pp. 65–7. See *The Friend,* pp. 143–7; *Aids to Reflection,* pp. 233–4.

in knowing, it can be aware of itself knowing, and thus aware of its distinction from the remaining natural universe.[20]

More importantly, Coleridge believed that self-awareness given by the Understanding insures the existence of a higher kind of knowledge. But before Coleridge could describe the implications of self-awareness, he felt he must postulate a faculty lying behind even that of consciousness: the moral faculty of conscience. Consciousness, said Coleridge, "presupposes the conscience as its antecedent condition and ground" (*Aids to Reflection,* p. 185). By placing the conscience, the faculty of judging rightly, prior to the knowing faculty, Coleridge at once identified morality with knowledge—even that knowledge which is least significant. Knowledge of the self thus becomes conditional upon right and wrong, conditional, therefore, on a determination which exists outside the self. Elsewhere in *The Friend,* Coleridge did explicitly identify the conscience with the laws of God, for he described the conscience as "the power, and as the indwelling word, of a holy and omnipotent legislator" (p. 106).

Coleridge also believed that the working of the conscience determined the working of the will.[21] Since the will directs the mind to the right possession of knowledge, it thus becomes analogous in function to the instinct. For the will directs the mind to spiritual truths, just as instinct directs the mind towards knowledge of the material world. As Coleridge said early in *The Friend,* "All speculative truths . . . suppose an act of the will; for in the moral being lies the source of the intellectual" (p. 108). (Coleridge, however, rather confused the issue when he said later in *The Friend,* ". . . all morality is grounded in reason" and reason is "the fountain of all morality" [pp. 175,6].) The will is then identified with self-knowledge, perhaps self-awareness, as that which defines the individual self: "that will which is the true and only strict synonyme of the word, I, or the intelligent Self" (*Aids to Reflection,* p. 196). However, the will, like the conscience, is a spiritual power, existing above the natural world because of its ability to determine itself. Said Coleridge in the *Aids to Reflection,* "If there be aught spiritual in man, the Will must be such" (p. 192).

Although man is given the faculty of will, a faculty above nature, as an indication of individuality and for the purposes of knowledge, Coleridge also identified the will of man, as he had before the Ideas,

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[20] ". . . in every act of conscious perception, we at once identify our being with that of the world without us, and yet place ourselves in contradistinction to that world," *The Friend,* p. 449.

[21] Coleridge asserts that the law of conscience "commands us to attribute reality, and actual existence" to the idea of "free-will, as the power of the human being to maintain the obedience which God through the conscience has commanded, against all the might of nature." *The Friend,* p. 106. In *Aids to Reflection,* Coleridge says again that the "responsible WILL" is the subject of the law of conscience, p. 195.

with the Laws working themselves out in nature. "In irrational agents, namely, the brute animals, the will is hidden or absorbed in the law" (*Aids to Reflection,* p. 296). And Coleridge assumed that the will, though spiritual in nature, could not operate in the isolation of the spirit since it determines action in a material world.[22] Thus the distinctions between the natural and the spiritual may again be obscured, as the will functions in the realms of each.

Nevertheless, Coleridge more frequently saw the will working in conjunction with Reason. The will operates upon Reason in some way to inform that knowledge which belongs to the rational faculty. "For the personal will comprehends the idea as a reason, and it gives causative force to the idea, as a practical reason" (*Aids to Reflection,* footnote, p. 296). Applying concretely the rule of the golden superlative, Coleridge then defined the self, and self-knowledge in terms of Reason. He said in *The Friend,* "Whatever is conscious self-knowledge is reason," and with Reason comes "self-consciousness, and personality, or moral being" (pp. 145,4).

As everyone knows, Coleridge felt that Reason is the highest faculty possessed by man, that faculty which allows man to know absolute truth.[23] Thus reason must be possessed equally by all men.[24] Thus, too, as René Wellek says, the knowledge given by Reason is intuitive.[25] For Coleridge said, in the *Aids to Reflection,* that "Rea-

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[22] ". . . therefore the will is pre-eminently, the spiritual constituent in our being. But will any reflecting man admit, that his own will is the only and sufficient determinant of all he is, and all he does? Is nothing to be attributed to the harmony of the system to which he belongs, and to the pre-established fitness of the objects and agents, known and unknown, that surround him, as acting on the will, though doubtless, with it likewise?" *Aids to Reflection,* p. 150.

[23] Early in *Aids to Reflection,* Coleridge sees Reason "comprehending the will, the conscience, the moral being," for Reason "is the organ of wisdom, and, as far as man is concerned, the source of living and actual truths," p. 215. See also *The Friend,* pp. 143–150; *Aids to Reflection,* pp. 233–4; *The Statesman's Manual,* p. 439; "Appendix B," *The Statesman's Manual,* pp. 456–63; *Logic,* p. 110.

[24] "Every man is born with the faculty of reason. . . . In respect of their reason all men are equal." *The Friend,* pp. 175–6.

[25] René Wellek, restating his contention that Coleridge is caught between a dualism of logic and faith says, "Coleridge is defending a dualism between logic, for which he has a traditional awe, and some sort of superlogical instrument of philosophy, instead of seeing that there is only one Reason which knows the highest and the lowest truth," p. 81. Later he says, "Coleridge's Reason is, first and foremost, dangerously similar to intuition," p. 127. Commenting on Coleridge's *Essay on Faith,* he says "Reason is intuitive," p. 133. Muirhead, in *Coleridge as Philosopher,* denies the intuitive nature of reason, pp. 106–110. In "Metaphysician or Mystic," written in answer to Wellek, he qualifies his position by saying, "It is that the work of the reason, as the highest of which the mind is capable and as the expression of its own inner unity, is in essential continuity with that of sense and understanding. If it seems to act intuitively, the intuitiveness is an 'intellectual' one, and that makes all the difference. For it means that however immediate the act may seem, it is penetrated with a light which it owes to the organizing power of thought," pp. 191–2. Miss Coburn defends Coleridge's subjectivity generally by saying, "It surely does not invalidate his critical or systematic views at all to suggest that in this sense their great strength and piercing insight depend largely on the subjective element in them," p. 17. The difficulty lies, I think, not in the fact of the subjective and ultimately intuitive nature of knowledge, but in the failure on Coleridge's part to distinguish between what he felt true and false intuition, true and false subjectivity, and his extraordinary distrust of those very faculties (mind and emotion) upon which he was forced to ground his philosophical speculations.

son . . . affirms truths which no sense could perceive, nor experiment verify, nor experience confirm" (footnote, p. 252). Moreover, Coleridge believed that the intuitive truths of Reason can not and should not be forced to correspond with ratiocinative logic: "Wherever the forms of reasoning appropriate only to the natural world are applied to spiritual realities, it may be truly said, that the more strictly logical the reasoning is in all its parts, the more irrational it is as a whole" (*Aids to Reflection,* p. 265).

Coleridge also defined Reason as the unifying spiritual force within man. Because it is a force for unification, and not a mere receptacle of knowledge, it gives meaning to those other faculties possessed by man. Like the will and the conscience, Reason is the "calm and incorruptible legislator of the soul, without whom all its other powers would 'meet in mere oppugnancy'" (*The Friend,* p. 176). Reason provides the basis for man's own organization by directing man's thinking towards the highest object of knowledge, God. Because man can know God intuitively through the Reason, all knowledge is given validity and truth.[26]

Coleridge nevertheless did not or could not terminate his conception of Reason at this point. Although Reason subsumes all knowledge—both spiritual and natural—under its knowledge of God, an orthodox conception, Coleridge then identified Reason with the object of knowledge itself. Reason becomes both knower and known. Coleridge said in *The Friend,* "But then it must be added, that it [reason] is an organ identical with its appropriate objects. Thus God, the soul, eternal truth, &c., are the objects of reason; but they are themselves reason" (pp. 144–5).[27] René Wellek quite correctly sees statements like these concerning Reason as indicative of a doctrine very close to "neoplatonic Pantheism."[28] But Coleridge goes even further.

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[26] "Only by the intuition and immediate spiritual consciousness of the idea of God, as the One and Absolute, at once the ground and the cause, who alone containeth in himself the ground of his own nature, and therein of all natures, do we arrive at the third, which alone is a real objective, necessity. Here the immediate consciousness decides: the idea is its own evidence, and is insusceptible of all other. It is necessarily groundless and indemonstrable; because it is itself the ground of all possible demonstration. The reason hath faith in itself in its own revelation." *The Statesman's Manual,* p. 439. See also *The Statesman's Manual,* p. 430.

[27] See also the *Inquiring Spirit,* where Coleridge proceeds into metaphor: "Lastly, there is, it is admitted, a Reason, to which the Understanding must convert itself in order to obtain from within what it would in vain seek for without, the knowledge of necessary and universal conclusion—of that which is because it must be, and not because it had been seen. May there not be a yet higher or deeper Presence, the source of Ideas, to which even the Reason must convert itself? Or rather is not this more truly the Reason, and the Universal Principles but the Gleam of Light from the distant and undistinguished community of Ideas—or the Light in the Cloud that hides the Luminary? O!" p. 126; also *Logic,* p. 86; footnote, *The Friend,* p. 465; footnote, "Appendix B," *Aids to Reflection,* p. 463. (Early in the *Aids to Reflection,* Coleridge denied the validity of pantheism, however, when he said, "I hold then, it is true, that all the so called demonstrations of a God either prove too little . . . or too much, namely, that the World is itself God," pp. 220–1. Nevertheless, Coleridge's position finally represented a variation of Neoplatonic pantheism.)

[28] pp. 128–9. Later he says, "Reason, besides, is one with the absolute Will, the Logos, the certain representative of the will of God in opposition to the individual

Man's Reason has been defined as God's Reason. Later in *The Friend,* Coleridge redefined individual man, not in terms of the will, self-awareness, or Reason, but explicitly in terms of infinitude and universals. "For considered merely intellectually, individuality, as individuality, is only conceivable as with and in the universal and infinite, neither before nor after it" (*The Friend,* p. 469). While it is difficult to understand how time exists before or after infinity, Coleridge here bypassed the more respectable doctrine of contemplation to assert the individual's necessary participation in and identification with the infinite.

With this concept, of course, Coleridge's attempt to structure the external universe and man within that universe totally collapses. The concept of the individual, as such, is lost in infinity, as is the possibility of knowledge peculiar to the individual. The ability to know the natural world in terms of man's own individual order has been forgotten in the necessity to expand him into God's being. On such a plane, knowledge itself becomes existence: ". . . to know God is . . . a vital and spiritual act in which to know and to possess are one and indivisible" (*The Statesman's Manual,* p. 449). Coleridge said this more metaphorically in the *Anima Poetae,* where he saw the philosopher "still pushing upward . . . towards the common source whose being is knowledge, whose knowledge is being—the adorable I AM IN THAT I AM" (p. 262).[29]

In *The Friend,* Coleridge traveled yet another mile forward on the mystical road as he redefined infinity in terms of man. God, or absolute being, is dependent for existence upon man, the created: "By the former [reason] we know that existence is its own predicate, self-affirmation, the one attribute in which all others are contained, not as parts, but as manifestations. It is an eternal and infinite self-rejoicing, self-loving, with a joy unfathomable, with a love all-comprehensive. It is absolute; and the absolute is neither singly that which affirms, nor that which is affirmed; but the identity and living *copula* of both" (pp. 469–70).

Obviously, Coleridge has been forced into an epistomological paradox in his endeavor to express such "an existence incomprehensible and groundless, because the ground of all comprehension" (*The Friend,* p. 468). But the fact that he finally achieved a concept based on paradox can explain, I think, many of the conflicts found among his scattered statements and attempted definitions. For Coleridge, that knowledge possessed by the Understanding in

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will. Again it is quite uncertain in what relation this individual will stands to Reason," p. 133. See also footnote, "Appendix B," *Aids to Reflection,* p. 460, and p. 458.

[29] See also *The Friend,* where Coleridge said that the elevation of the spirit to the world of spirit is not a "sort of knowledge: no! it is a form of BEING, or indeed it is the only knowledge that truly *is,* and all other science is real only so far as it is symbolical of this," p. 472.

relation to an ordered universe was true only relatively, even though at times he seems to have felt that this knowledge had absolute value. From a higher point of view, the point of view of the Reason in its infinite existence, such distinctions are only manifestations of a single infinite unity.[30] In *The Friend,* Coleridge explained this belief in terms of the difference between "substantial" and "abstract" knowledge. The terminology here is significant, since the one predicates a knowledge which has actual existence and the other only a nominal meaning:

> The groundwork, therefore, of all pure speculation is the full apprehension of the difference between the contemplation of reason, namely, that intuition of things which arises when we possess ourselves, as one with the whole, which is substantial knowledge, and that which presents itself when transferring reality to the negations of reality, to the ever-varying framework of the uniform life, we think of ourselves as separated beings, and place nature in antithesis to the mind, as object to subject, thing to thought, death to life. This is abstract knowledge, or the science of the mere understanding. By the former, we know that existence is its own predicate, self-affirmation, the one attribute in which all others are contained, not as parts, but as manifestations. (p. 469)

Coleridge felt that this "substantiating principle of all true wisdom" presented "the satisfactory solution of all the contradictions of human nature, of the whole riddle of the world" (*The Friend,* p. 471). Seen from this peak, the contradictions in Coleridge's own fragmentary epistemology partially disappear. His various categories of thought and existence, the will, the conscience, the division between the Reason and the Understanding, all become attempts to separate artificially what is inseparable, and indeed only another aspect of the single unity.[31] So Coleridge could and did calmly reconcile Plato and Bacon into a new synthesis.

However, Coleridge's elaborate system of categories somewhat unhappily illustrates the difficulty of his attempt to "distinguish without dividing"—the function of the Understanding—as he ran the danger himself of committing his own worst heresy.[32] Further-

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[30] Nearly all Coleridge's critics, of course, have recognized Coleridge's search for "unity in diversity," as the guiding principle of his metaphysics. Muirhead states this perhaps most succinctly: "Whatever changes Coleridge's philosophical opinions underwent, one thing remained fixed and constant, the guiding star of all his wanderings, namely, the necessity of reaching a view of the world from which it could be grasped as the manifestation of a single principle, and therefore as a unity," p. 60. Thus it seems only logical to realize also that Coleridge's epistemological thinking paralleled his metaphysical thinking. In the *Aids to Reflection,* Coleridge said, "It is the office, and as it were, the instinct of reason, to bring a unity into all our conceptions and several knowledges," p. 210. See also *The Statesman's Manual,* p. 450.

[31] Coleridge said this another way in *The Friend,* speaking of "that reason in which the essences of all things co-exist in all their distinctions yet as one and indivisible," p. 466.

[32] See *The Friend,* p. 470; "Appendix B," *The Statesman's Manual,* where reason, religion or will "loses its own nature at the moment that from distinction it passes into division or separation," p. 457; and "Appendix B," *The Statesman's Manual,* p. 461.

more, in view of his condemnation of the feelings, and of mystical intuition as a false foundation of knowledge, his own construction of a universe known fully only through mystical participation in the infinite is peculiarly ironic. Nevertheless, his desire to give man knowledge as well as existence beyond the accepted limits must be seen, I think, as a very valiant effort on the part of a man who was always able to think more arduously, if not more coherently, than most of his contemporaries.

SHELLEY'S "ALASTOR" AND ROMANTIC DRAMA

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"Alastor; or the Spirit of Solitude" is not the most popular of Shelley's poems, but among critics it apparently occupies the place of a favorite problem child. It is Shelley's earliest long poem after "Queen Mab," and although it exhibits a remarkable increase in poetic power in the two years between the poems, it also presents new and extraordinary problems, the solution of which challenges the ingenuity, and sometimes the patience, of its critics.

The central problem faced by these critics is that of determining just what kind of performance it is. Clearly intended as a major statement of some sort—with a preface by the poet and in the later editions a note by Mrs. Shelley—the poem deals with readily identifiable, and in some cases typically Shelleyan, themes. But these themes are presented in a strange and apparently disunified form, so that the hardest questions to answer are: what sort of poem is it, and what does it say? In attempting to answer these questions critics have discovered at least two major difficulties which complicate, if indeed they do not cause, the central interpretative problem. The first of these is an alleged contradiction between the poem itself and Shelley's statements about the poem in his preface. The second is a supposed inconsistency between the events of the narrative and Shelley's attitude toward the central character participating in these events.

The preface is said to be in conflict with the poem on two issues: in suggesting a single purpose for the poem, and in intimating that a curse motif informs the poem. Shelley is said to have erred when he implied that his poem has a single purpose, for manifestly the poem answers to four nearly distinct purposes, a characteristic explained by the fact that Shelley was a confused poet, not sure about what he was writing in the heat of composition.[1] One may infer that Shelley's error in the preface is explained by his further inability to interpret what he had done when the work was finished. This explanation—if it affords any satisfaction at all—can hardly account for the second alleged inconsistency. Shelley implies, it is said, in the second paragraph of his preface, that a curse motif is

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[1] Raymond D. Havens, "Shelley's Alastor," PMLA, XLV (1930), 1098–1115. His evidence for Shelley's "confusion" is Shelley's own account of his *modus scribendi* to Godwin in a letter of February 24, 1812 (p. 1106).

at work in the poem, whereas the poem itself does not reveal such a motif. The first paragraph of the preface, furthermore, does not bear out the implication of the second, thereby betraying still another inconsistency within the preface itself. The title, which does suggest a curse motif, was composed, not by Shelley, but by Thomas Love Peacock, and Shelley was apparently forced to write the second paragraph to account for his adopting the title.[2] In addition, Shelley insists in the preface and early in the poem that the central figure, the Poet, deserves punishment, whereas the concluding lines of the poem contain extraordinary praise of the Poet, praise so completely unqualified as to obscure or negate this earlier judgment.[3]

What this complex of charges against the poem suggests is that, if Shelley was not himself hopelessly confused indeed, the methods of modern criticism have not yet been able to account for the value of the poem. In general, criticism when it is fair asks first what a poet is trying to accomplish in his poem, and second how well he has succeeded. The charges against "Alastor" proceed from the critics' discovery that Shelley was not sure what he was trying to accomplish, that success was therefore impossible. Perhaps a restoration of the poem can best be achieved, then, by assuming that the poem is a success, and by deducing from it just what it succeeds in doing.

The charge, for example, that Shelley's attitude toward the central figure is inconsistent, can only be made on the assumption that Shelley wanted *either* to assert that the Poet is "wrong," *or* to hold him up as a superior man. This restriction of Shelley's purpose ignores the fact that Western literature is filled with "tragic heroes," superior men who do something wrong;[4] and this reflection is the first indication of Shelley's real intention in writing "Alastor."

I believe that "Alastor" is an early attempt by Shelley to bring within the scope of his own Romantic poetics the tradition of European drama. Shelley's later efforts in this direction are well recognized as perhaps the nearest thing to successful Romantic drama: his attempt to revitalize Elizabethan tragedy in *The Cenci,* and his attempt to transplant continental philosophical-drama in *Prome-*

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[2] Carlos Baker, *Shelley's Major Poetry: The Fabric of a Vision* (Princeton: Princeton University Press, 1948), pp. 42, 45. A. M. D. Hughes also concludes that the preface and the poem are inconsistent in "Alastor, or the Spirit of Solitude," *Modern Language Review,* XLIII (1948), 465–70.

[3] Frederick L. Jones, "The Inconsistency of Shelley's *Alastor*," *ELH,* XIII (1946), 291–98. At least two critics have regarded the poem as consistent: Evan K. Gibson, "*Alastor*: a Reinterpretation," *PMLA,* LXII (1947), 1022–45; and Albert Gerard, "*Alastor,* or the Spirit of Solipsism," *Philological Quarterly,* XXXIII (1954), 164–77.

[4] Gibson refers to the "tragedy" of the poem (p. 1027), and Gerard suggests that the poem is "cathartic" (p. 165), and that the Poet's "sin" is a "tragic guilt of ignorance" (pp. 175ff).

theus Unbound. His consideration of the drama from a thoroughly Romantic position in his *Defence of Poetry* is a third such effort, different of course in kind. I will try to show that "Alastor" is Shelley's fourth and earliest effort to incorporate the drama within his own lyrical poetic impulse.

"Alastor," like *Prometheus* but perhaps not so consciously, is organized around a classical myth: the myth of the unloving young man who is destroyed by love in a perverted form. Euripides tells the story in the *Hippolytus* of a young man's worship of Diana to the neglect of Venus, and how it results in his punishment by Venus through an incestuous love kindled in his step-mother, Phaedra. Driven by her passion and its accompanying resentment at Hippolytus' refusals, Phaedra provokes her husband and Hippolytus' father, Theseus, to execute his son. In Seneca's play, titled either *Hippolytus* or *Phaedra,* there is a scene in which Phaedra herself reveals her love (a direct confrontation apparently too horrible for the Greek audience) as well as much greater emphasis on the ravages which her unnatural love makes in Phaedra. It is this last aspect of the traditional story which clearly predominates in Racine's version, so clearly that perhaps only the story remains, and very little of its mythical import. O'Neill's *Desire Under the Elms* seems to restore or rework the myth at the same time that nearly every aspect of the story is changed. Abbie Putnam Cabot, the female component, is the central character. She dishonors love by insincerely performing its rites with her step-son, Eben, in order to inherit his father's property. She is led to murder the infant born of this illicit union when genuine and irresistible love for Eben makes her resent his repudiation. In every case the elements of the myth, whatever their order and emphasis, are the same: a failure to honor love, or its spirit, or its goddess; an unnatural love; the death of an innocent person; and a sense of justice or necessity in the relationship among the other elements, religious in Euripides and Seneca, ethical in Racine, ironic in O'Neill.

In Shelley's version, "Alastor," the central figure is a solitary who fails to identify himself through love with humanity as a whole. Accordingly, the spirit of human love sends him a vision—an ideal mate constructed from the qualities, potentialities, and requirements of his own nature. The Poet thereafter searches for the prototype of this vision throughout the world, finally seeking union with her in death. The meaning of the myth here is not far from that in the Euripides version: natural love denied will be revenged. It is love of humanity as a whole, however, that Shelley expects of us, and he emphasizes his condemnation of spiritual solitude by extraordinary poetic condensation. The terrors of unnatural love, which Euripides, Seneca, and Racine assign to another person, the

Phaedra figure, Shelley attaches to the hero himself; the hero dies by his own deluded will, and not by the intervention of a Theseus; and he remains all the while the innocent victim.

If we consider the poem, then, as a typically Romantic effort to combine the lyric and dramatic forms, with a tragic myth and a tragic hero, the problems of "Alastor" can be resolved in this way. First, the organization around a single purpose which Shelley claims for the poem in his preface is now borne out by the poem itself. Whatever secondary purposes he may have intended are subordinated to a clear organizing and unifying principle, the Hippolytus myth. The alleged confusion in Shelley's mind as he wrote is actually nothing more than the reflection of his own doctrine in the *Defence* that true poetry comes unbidden and unconsciously to the poet. The opening lines of "Alastor" clearly anticipate—as in a dramatic chorus—the poem's ending, thereby revealing that at some point in the composition, most probably at the beginning, Shelley had a clear vision of the whole work. The so-called curse motif of the second paragraph of the preface is actually present in the myth, and consequently in the poem, and by implication in the first paragraph of the preface. In adopting Peacock's title, then, Shelley was only carrying out his original and single concept of the poem.

The problem of the inconsistency of the Poet's "sin" and Shelley's attitude toward him arises, as I have suggested, from the draratic character of the poem. The Poet's sin is, as Shelley says in the preface, a "generous error," or, as we might say, a tragic mistake. The praise of the Poet at the end is clearly intended to evoke the traditional tragic response of *pity,* and the statement in the preface that the poem "is not barren of instruction to actual men" justifies the assumption that we are also expected to feel tragic *fear.*

Certain peculiar accidents seem to carry over from Seneca's drama into Shelley's narrative, accidents which suggest that the Roman play was influential in the composition of "Alastor" in more ways than as the means by which Shelley came to know the Hippolytus myth. Although Shelley's hero could never be a hunter, for example, since hunters are on the Shelleyan black-list of inhumane and savage villains, the association of the hero with Diana is preserved in Shelley's poem by numerous references to two of Diana's provinces: the moon and the secret places of the earth. The peculiar fact that "youthful maidens" called the Poet "false names / Brother and friend" (11. 266–69) seems to echo the scene in which Seneca's Phaedra asks Hippolytus to call her "sister." Even the Poet's meeting with the swan and his observation, in the conventional way, that his own voice is "far sweeter than thy dying notes," (1. 286) suggests the tribute which Seneca's chorus pays to Jupiter, that he has "dulcior vocem moriente cygno." These similarities are insuffi-

cient to justify the attribution of an influence of Seneca on Shelley, although they are interesting in themselves, and we know from Mrs. Shelley's notes to the "Early Poems" that Shelley was reading Seneca about the time he wrote "Alastor." Yet while random parallels such as these do not prove by any means that "Alastor" is based on Seneca's *Hippolytus*, if the identity of the myth in both works is recognized, the occasional echoing of Seneca may help to solve incidental problems in Shelley's poem.

The only real evidence that Shelley's poem is an "Hippolytus-poem" is the poem itself, and the importance of recognizing the operation of the myth in the poem is chiefly that the major problems of interpretation can be solved in this way. It is also significant, however, that we find Shelley trying so early in his career to enlarge the formal possibilities of literature in the Romantic spirit by combining lyric and dramatic virtues.

SWIFT AND THE ANIMAL MYTH*

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Most modern critics have acknowledged the importance of the animal myth as a recurrent element in the work of Swift. Nevertheless there has been no single attempt to regard Swift's art in the light of the happy beast tradition, particularly as it developed in French thought. That Swift was fully aware of that tradition there can be no doubt: besides the many explicit and implicit references he makes to the fabulists, there is his library, which contained every important figure that contributed to the tradition—Aesop, Pliny, Plutarch, Phaedrus, Montaigne, Descartes, Boileau, La Fontaine.[1] What he found and borrowed from the tradition, and what he himself added to it will be the subject of my paper.

First of all, what precisely is the "animal myth"? Namely this: that the animal kingdom consists of types, laws, and interrelationships that approximate human society. How universal this notion is is suggested by the beast fables that most countries and ethnic groups possess as part of their folk lore and literature. As a literary form the fable generally has one of three basic purposes: simply to amuse, to instruct, or to satirize. Aesop's tales, the greatest early collection in Western literature, are didactic. They teach us—and how un-American Aesop was!—not to resist tyranny actively but to endure it.[2] When, for instance, the lion, symbol of governmental authority, withdraws from his promise by taking an unequal share of the donkey's carcass, the fox, symbol of the citizen, accepts his meagre portion disgruntled but acquiescent. Though Aesop's fables are not intentionally satiric, they furnished later satirists with a convertible prototype by easily lending themselves to a disparaging image of man: for human dignity is nowhere to be found in them; cruelty, deceitfulness, and ignorance, everywhere.

When in Rome the animal myth did as the Romans and became satirically oriented. That animals had souls had been previously propounded by several Greek philosophers and is a theory that informs, of course, the Pythagorean concept of reincarnation. More important to the Romans interested in chastizing man, however,

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[1] Harold Williams, *Dean Swift's Library* (Cambridge, 1932). Of all the books Swift possessed, nearly one-fifth were French.

[2] Jean de La Fontaine, "La Vie d'Esope," *Fables, Contes et Nouvelles* (Paris, 1932), pp. 13–28.

was animal reason. If, as Aristotle had believed,[3] animals could be shown to be rational creatures, then man, with his depravity and overriding vices, would fare ill by comparison. Accordingly, writers such as Pliny, Plutarch, and Phaedrus espoused what is technically called "theriophilism," i.e. the glorification of animals. "To man alone, of all animated beings," cries Pliny, "has it been given to grieve, to him alone to be guilty of luxury and excess. . . ."[4] Plutarch in turn, espousing theriophilism to an extreme, inverts the normal conception of rationality and bestiality. For him animality is equivalent to pure reason and human reason to what is usually considered bestial. When, for example, Gryllus, the man metamorphosed into a pig by Circé, rejects Ulysses' offer to regain his former shape, he gives as one reason for his refusal the preferred state of his mind, which now has an understanding "purified" of the base desires of mankind.[5]

Plutarch's inversion effects a paradox that dogs the happy beast tradition, confronting even Swift himself: to attain perfectibility man must follow the example of lions, tigers, and kangaroos; but to do so he must renounce learning and every other intellectual endeavour that not only separates him from the animal state but tends to increase his reasoning power. In other words man must become more bestial to become more reasonable. This dilemma appears less torturous when one realizes that Plutarch was confusing animal reason with instinct, that natural, untainted faculty that guards its owner against human viciousness. Nevertheless, Plutarch's two poles of reason were maintained by French writers of the sixteenth and seventeenth centuries who carried the tradition to its most controversial stage.

Montaigne, like Plutarch, sets upon man's ego, but in lieu of emphasizing animal rationality he stresses human ignorance, presumption, and vanity. Thus, in a famous passage in his essay, *The Apology of Raymond Sébond* he says: "When I play with my cat, who can tell whether or not she is diverting herself with me more than I am with her?"[6] If animals are unable to understand our language, we are no better off in failing to understand theirs. It is because of his vanity that man considers himself superior to the beasts, his vanity that blinds him to the true state of nature. In undercutting man's pride Montaigne lumps animal and human nature together, and consequently sees greater resemblance between individual temperaments of different species than of the same species.[7]

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[3] Cf. *Historia Animalium*, Bk. I. i; VIII, IX.

[4] *The Natural History*, trans. John Bostock and H. T. Riley (London, 1855), Bk. VIII, ch. i, p. 118.

[5] "Beasts Make Use of Reason," *Morals*, ed. W. W. Goodwin (Boston, 1883).

[6] *Essais*, ed. Pierre Villey (Paris, 1922), Bk. II, ch. xii. My translation.

[7] *Ibid.*, p. 183.

Montaigne's overthrow of the established cosmic order of nature wherein man holds a medial position below the angels but above the animals evoked opposition from those who felt that he and his disciples, Charron and Pasquier, were undermining Christian precepts by espousing a primitivistic cause which would lead man ultimately to beastliness in its most depraved form. The foremost anti-theriophilist was, of course, Descartes, who insisted that animals are primarily only mechanisms, though incomparably better organized than any machine man could devise.[8] They have, moreover, no reflective reason and although they possess a soul it is instinctive, merely directing their actions automatically, and dies with the body.[9] Man's reason is, therefore, superior because it is intellective, not merely instinctive and mechanical. In this way Descartes attempted to solve the paradox of rational animality.

But Descartes' anti-theriophilistic arguments were themselves strongly opposed.[10] Time permits mention of only Boileau and La Fontaine. Motivated by a satiric urge and following Plutarch, Montaigne, and their disciples, Boileau snipes at man's vanity by praising animal wisdom. Man, he asserts, is the only being who wars against his species. Though he purports to rule other creatures he is actually ruled by his own passions.[11] La Fontaine answers Cartesian mechanism by allowing animals a reasoning power similar to that of children in its limited capacity to perceive and make imperfect judgments only, not to reflect or construct complex ideas from the images the mind receives. On the question of animal spirituality La Fontaine maintains a Christian balance. Man's soul, that is, is twofold: one part has divine immortality and the other brute mortality. This duality thus accounts for the paradox of man's heavenly aspirations and terrestrial occupations.[12]

In England, where the controversy was engaged in with less audacity and originality than in France, the Cartesians lost ground to the theriophilists. Milton, for instance, concedes "much reason" to animals.[13] John Gay, echoing Boileau, accuses man of being the only animal of prey to herd together hypocritically.[14] And in his *Free Thoughts upon the Brute Creation* (1742) John Hildrop, a minor figure, grants immortality to the animal soul. This high regard for the animal kingdom has been ascribed by one modern scholar to the current of humanitarianism overspreading Europe at this time: "Men abandoned the love of God for the 'love of

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[8] *Discours de La Méthode* (Paris, 1948), p. 102.

[9] *Ibid.*

[10] For a succinct survey of this issue see A. Lytton Sells, *Animal Poetry in French & English Literature & the Greek Tradition* (Bloomington, 1955), pp. xviii ff.

[11] See his eighth satire, "Sur l'Homme" (1667).

[12] Cf. the fable of "The Two Rats, The Fox, and The Egg," and also the "Discours à Madame de La Sablière."

[13] Cf. *Paradise Lost,* IX, vv. 552–59.

[14] *The Beggar's Opera,* III. ii.

humanity,' as they thought; and it was felt that this should be extended to animals, when convenient."[15]

These then are only a few of the many contributors to the rather complex happy beast tradition. They may, nevertheless, be taken as representing the attitudes of the theriophilists and their opponents.[16]

When considering Swift's relation to the above tradition one must keep constantly in mind three significant points: 1) Swift was a sincere Anglican divine; 2) he was an extremely clear and consistent thinker; 3) he was a conscious artist. Hence, we can rest assured that when he adopted the animal myth as part of his satiric machinery he was fully cognizant of the implications involved in the assimilation of man to beast.

Swift's purpose in using the animal myth is closely related to his Christian view of the universe. As the Dean of St. Patrick's he upholds the traditional view of man's position in the creation. He maintains, that is to say, that the "Scripture-system" is what we are to believe: Adam was formed from clay, Eve from one of his ribs; the Creator intended man "to rule over the beasts of the field and birds of the air"; before the fall man wielded absolute power over them, but after tasting the forbidden fruit he was rejected as terrestrial ruler.[17] The document from which this abstract has been taken is so relevant to our topic that part of it, at least, warrants quotation:

> The first monarch after the flood was Nimrod, the mighty hunter, who, as Milton expresseth it, made men, and not beasts, his prey. For men were easier caught by promises, and subdued by the folly or treachery of their own species. Whereas the brutes prevailed only by their courage or strength, which, among them, are peculiar to certain kinds. Lions, bears, elephants, and some other animals, are strong and valiant, and their species never degenerates in their native soil, except they happen to be enslaved or destroyed by human fraud: But men degenerate every day, merely by the folly, the perverseness, the avarice, the tyranny, the pride, the treachery, or inhumanity of their own kind.[18]

It is apparent from this passage that Swift accepted brute nature as quite distinct from human nature. To him beasts conform more naturally to their position in the chain of being, while man tends to degenerate to a baser condition because of his progenitor's binding sin. But however pure animal nature may be and however much

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[15] Sells, *op. cit.*, p. xxvi f.

[16] In addition to Sells' book, the following works have proved useful to me for the above synopsis: Dix Harwood, *Love for Animals and How it Developed in Great Britain* (New York, 1928); George Boas, *The Happy Beast* (Baltimore, 1933); Leonora C. Rosenfield, "Un Chapitre de l'Histoire de l'Animal-Machine (1645–1749)," *Revue de Littérature* Comparée, XVII (1934), 461–87, and *From Beast-Machine to Man-Machine* (New York, 1940).

[17] "Further Thoughts on Religion," *The Prose Works of Jonathan Swift,* ed. Herbert Davis (Oxford, 1938–41), IX, 264.

[18] *Ibid.*

Swift glorifies it, it can never surpass human nature; for man alone is potentially capable of salvation inasmuch as his species only is *rationis capax*. Nevertheless, the animal state can teach man how to live consistent with the divine part of his own being. Swift seems to imply this belief in two noteworthy places:

> Creatures of ev'ry Kind but ours
> Well comprehend their nat'ral Powers;
> While We, whom *Reason* ought to sway,
> Mistake our Talents ev'ry Day.[19]

And again in a religious context: "God Almighty hath been pleased to put us into an imperfect State, where we have perpetual Occasion of each other's Assistance. There is none so low, as not to be in a Capacity of assisting the Highest; nor so high, as not to want the Assistance of the Lowest."[20] The assistance of the brute, the lowest, can only be of an exemplary kind, but it is still assistance and as such constitutes part of Swift's satiric attack on mankind.

One of Swift's borrowings from the animal myth is the fable form itself, which he uses primarily for political purposes, as is evidenced by the series of fables written between 1710 and 1715, his most politically active period. Herein lies his obvious debt to Aesop. Swift's fables are remarkable for their wit and insinuating allusions, qualities which distinguish them from their predecessors. The fables of Aesop and La Fontaine generally lack ironic statement, aiming rather at a single moral conclusion. But Swift weaves more than one moral into his: he implies other maxims while developing the primary one. One example will clarify this. *The Fable of the Bitches* (1715) was written in protest against the repeal of the Test Act. Its characters include Bawty the pregnant bitch, who represents the dissenters, Musick, another bitch, representing the Church of England, and the brood of offspring, also dissenters. The story is simple. Bawty, after having been refused refuge everywhere, begs and obtains asylum in Musick's house, where her pups are eventually born. In order to feed her offspring Bawty must devour everything in sight; but after several days Musick, in order to ward off starvation, civilly requests that Bawty and hers leave. The latter, however, begs and is allowed to stay on till her pups open their eyes. But when Musick returns some days later, Bawty sets her brood upon her and "drives her away from her right." The moral is, that if once the dissenters are given refuge in the Established Church they will thrive selfishly and soon turn upon their benefactors. And yet Swift describes the appetite of the new born pups so as to give richness to the characterization while at the

[19] "The Beasts' Confession to the Priest," 11. 203–206. Citations from Swift's verse are based on *The Poems of Jonathan Swift*, ed. Harold Williams, 3 vols. (Oxford, 1958).

[20] "On Mutual Subjection," *Prose Works*, IX, 143.

same time effecting a subsidiary moral about the ravenous nature of dissenters in general. Bawty, to appease her pups, feeds upon anything she can find,

> WHOLE Baskets full of Bits and Scraps,
> And Broth enough to fill her Paps,
> For well she knew her num'rous Brood,
> For want of Milk, wou'd suck her Blood.[21]

Besides writing his own fables Swift had recourse to the well-known fables of Aesop and La Fontaine, allusions to which are scattered throughout his work. He borrows, for instance, the lion and the mouse to put in the Drapier's mouth as illustration of a point of honor: "It is no loss of honour to submit to the Lion, but who, with the figure of a Man, can think with Patience of being devoured alive by a rat?"[22] In another letter the Drapier compares the situation of the Irish peers who vie unsuccessfully with the English for social prominence to that of the frog who tried to contend with the ox.[23] It is evident from the nature of the two fables alluded to here that Swift often does more than simply clarify in analogical terms the argument he or his persona is advocating. One word or image, like a kaleidoscope, is capable of reflecting several patterns of meaning. Thus Swift's fabulous allusions not only add color and give a kind of universality to his discourse, they also assist in depreciating the object of his attack. In the *Drapier's Letters* William Wood is his target, but elsewhere anyone from a zany projector to a hypocritical preacher may be analogized in the same manner.

Swift's primary object in adopting the animal myth is to attack man's pride and vanity by contrasting the animal with the human state, to the latter's disadvantage. He discloses this intention ironically in the Advertisement to *The Beasts' Confession to the Priest:*

> The following Poem is grounded upon the universal Folly in Mankind of mistaking their Talents; by which the Author doth a great Honour to his own Species, almost equalling them with certain Brutes; wherein, indeed, he is too partial, as he freely confesseth: And yet he hath gone as low as he well could, by specifying four Animals; the Wolf, the Ass, the Swine and the Ape; all equally mischievous, except the last, who outdoes them in the Article of Cunning: So great is the Pride of Man.[24]

To make prideful man appear as insignificant as a louse is Swift's heartiest desire. Indeed, in a delightful poem, occasioned by the brass currency issue of 1725, this is what he does to William Wood, who is compared to three kinds of vermin: a wood-louse, because

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[21] Ll. 19–22.
[22] "A Letter to Mr. Harding," *Prose Works*, X, 20.
[23] "An Humble Address to Both Houses of Parliament," *Ibid.*, p. 130.
[24] Italicized in the original version.

it rolls up in a ball, as Wood rolls himself in his brass; a louse of the wood, which is swallowed for medicinal purposes, as Wood likewise should be; and a wood worm, whose curse can be blighted by scalding him in boiling water, as Wood should be in his own melted brass.[25] Likewise, in Book Two of *Gulliver's Travels* the king of Brobdingnag reduces all mankind in one swooping generalization to "the most pernicious race of little odious vermin that nature ever suffered to crawl upon the surface of the earth." Though the circumstances are not political, the objective is the same.

Swift is following ostensibly in the footsteps of Pliny and Plutarch, but he differs from them in one essential point: whereas they, as heathens, had little conception of the teleological purpose behind man's seemingly disparate state in nature, Swift as a Christian is aware of the humility necessary for man's salvation. Hence, though he situates man in an unfavorable light when comparing him to the beasts, he does not seriously advocate bestiality. He is primarily attacking man's pride, as Montaigne did earlier; but unlike Montaigne he does not endow his animals with intelligence equal or superior to man's—except for a specifically satiric intention.

The uniqueness of Swift's adoption of theriophilism lies in his synthesizing the two extremes of the tradition represented by Montaigne and Descartes. It is his Christian principles as well as his intellectual conservatism that are responsible for his neither denying that animals are "in their degree" wise and undegenerate nor affirming that man conducts himself at the prompting of his reason. Christian theology substantiates both, and so Swift, working from a central position, can consequently adopt Montaigne's doctrine of animal intelligence as well as Descartes' belief in the irrationality of the animal soul. Montaigne's partisan enthusiasm prompted him to exalt animal nature above its appropriate condition. Swift steers clear of Scylla. Descartes on the other hand argues for a mechanistic animal intelligence in an attempt to keep asunder two distinct faculties. Swift not only avoids this Charybdis, he satirizes Descartes' basic premise in *A Discourse concerning the Mechanical Operation of the Spirit.* For Swift, one extreme view was as untenable as the other. Like the theriophilists he could see the danger in too wide a breach between man and brute, the danger of pride. But like the anti-theriophilists he could also perceive the fearful danger in man's forgetting his own distinctive nature and becoming an irreclaimable victim of his animal passions. For Swift the solution to the dilemma lay in man's humble use of his reason, weak and imperfect though it may be.

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[25] "Wood, an Insect," *Poems,* I, 350–52.

In a celebrated letter to Pope, dated Sept. 24, 1725, Swift describes Arbuthnot, that virtuous and reasonable man whom he ardently admired, as "not without fault." If such an exemplary human being as Arbuthnot is not faultless, what then must be the less admirable specimens of mankind! The point, I think, is that Swift does not in the least expect infallibility in human beings. To accuse him of hopeless idealism is to misread him entirely.[26] Swift was not an idealist-turned-misanthrope; he was, as Professor Quintana has demonstrated, a Christian realist deeply aware of the proximity of carnality and spirituality. Thus his constant reminder to us how close we are to the bestial state:

> Although reason were intended by providence to govern our passions, yet it seems that, in two points of the greatest moment to the being and continuance of the world, God hath intended our passions to prevail over reason. The first is, the propagation of our species, since no wise man ever married from the dictates of reason. The other is, the love of life, which, from the dictates of reason, every man would despise, and wish it at an end, or that it never had a beginning.[27]

When Swift borrowed the beast tradition for his satiric aims he found himself precariously poised in the midpoint of a seesaw. In order to maintain his balance he had to shift his weight from one side to the other, now attacking man's pride in believing himself far removed from the animal state, now chiding man's tendency to identify human nature with animal. He is usually less vitriolic when he treats of man's propensity to link himself with brute nature than when condemning him for his pride. In fact, he often achieves a playfully ironic manner, as for instance in the following verses:

> AS Mastive Dogs in Modern Phrase are
> Call'd *Pompey, Scipio* and *Caesar;*
> As *Pies* and *Daws* are often stil'd
> With Christian Nick-names like a child;
> As we say, *Monsieur,* to an *Ape*
> Without offence to Human Shape:
> So men have got from Bird and Brute
> Names that would best their Natures suit.[28]

Similarly, in *A Letter to a Young Lady on Her Marriage,* he can joshingly write: "When I reflect on this [i.e. women's concern over fashionable clothes] I cannot conceive you to be Human Creatures, but a sort of Species hardly a degree above a Monkey; who has more diverting tricks than any of you; is an Animal less mischievous and expensive, might in time be a tolerable Critick in Velvet

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[26] John Bullitt, it seems to me, is victim of this kind of misreading. See *Jonathan Swift and the Anatomy of Satire* (Cambridge, U. S. A., 1953), pp. 2, 3, 17.

[27] "Thoughts on Religion," *Prose Works,* IX, 263.

[28] "The Description of a Salamander," 11. 1–8.

and Brocade, and for ought I know wou'd equally become them."[29] This last quotation exemplifies Swift's double-edged satiric method: the young lady's pride takes a lashing by her being compared to a monkey; but extreme theriophilism is also being satirized in the same stroke.

This complexity of purpose and method often makes Swift appear inconsistent, especially as he shifts from one viewpoint to another. But it is because he synthesizes two opposing points of view that he is able to satirize the very tradition whose concepts he adopts. Furthermore, whether Swift takes up cudgels for or against the theriophilists depends primarily upon the satiric occasion. For the fool who prides himself on his rationality he accepts the premise of the anti-theriophilists—viz., that animals are irrational brutes—though rejecting their conclusion that man is superior, and then proceeds to reduce the fool to that particular state of bestiality. Thus the proud man, who would sympathize with the anti-theriophilistic argument, is attacked on his own grounds. For the fool of the opposite persuasion Swift reverses the process just described. He now adopts the view that beasts are so wonderful and rational that they outwit human beings at their own game. And so he humanizes the animal in all but its shape. The final satiric touch is added when a credulous theriophilist has social intercourse with the animal as if nothing could be more natural.

In its most successful form this latter technique was brought to a climactic peak in the fourth voyage of *Gulliver's Travels,* where theriophilism reaches its logical extreme: the beast becomes the master, man the servant. Much of the hilarity of this book is due to the Houyhnhnms, whose forms are not at all suited for many of the human activities in which they engage.[30] The absurdity of a horse threading and sewing with a needle is indicative of the satiric comedy that until recent years had been completely overlooked by Swift's critics. The Houyhnhnms embody the ideal of the theriophilists to an outrageous degree, for they are neither bestial nor human. They exist only in their creator's imagination, as do the Yahoos. Indeed, the juxtaposition of Yahoo and Houyhnhnm illustrates Swift's frequent method of introducing two extremes of an issue and implying a preference that lies somewhere between them. Gulliver, too naive to catch the implication, is bewildered by the apparent dilemma and so chooses the side of the theriophilists, deciding that it is better to emulate a rational horse than remain in a state susceptible of comparison with the odious Yahoo. The incongruity of his determined way of life does not occur to him

[29] *Satires and Personal Writings by Jonathan Swift,* ed. Alfred W. Eddy (Oxford, 1944), p. 67.

[30] I am indebted for this particular point to Edward Stone's article, "Swift and the Horses: Misanthropy or Comedy? MLQ, X (1949), 367–76,

because he sees only one side of the question. But Swift would have us see both sides—in order that we might choose a third.

Because, in conclusion, theriophilism was germane to the important issue of man's nature, Swift was magnetically attracted to it. And, as is usual with him, he took from the tradition what he needed for his own purposes, synthesizing, compromising, satirizing, and developing finally what for him, at least, was the only possible solution to the paradox of the happy beast.

THE WASHBURN OBSERVATORY, 1878–1959*

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Eighty years ago the science of astronomy had not yet entered the modern era of astrophysics. The popular idea of an astronomer as an old, bearded philosopher peering through a telescope was almost literally true. Astronomical discoveries were being made by visual methods only, since the art of photography was in its infancy and had barely been applied to astronomy. Mathematical astronomy was of great importance and the most famous astronomers of the first three quarters of the nineteenth century belonged to that branch of the science. One branch of observational astronomy was positional astronomy—which consisted of making accurate measures of star positions with a transit instrument.

It is true that the spectroscope was being used for the study of stellar spectra, but these spectroscopic observations were limited to the brighter stars and the classification of stellar spectra had just been suggested. Other physical instruments had not been successfully used for studying the stars, partly because they were not adapted to the study of light as faint as starlight. Many of course had not been invented.

So the astronomical investigations of that epoch were limited to the discovery of comets with small telescopes, search for new satellites of the planets with the largest telescopes, and the discovery of minor planets, double stars and nebulae with whatever equipment was available. These surveys of the sky were being conducted in many parts of the world, principally in Europe and to a limited extent in the United States.

In 1876 the Wisconsin State Legislature passed a bill appropriating funds for the upkeep of an observatory at the university, should one be built and equipped and then given to the university.

In 1877 former governor Cadwallader C. Washburn announced his intention of building and equipping such an observatory. He selected the picturesque and beautiful site atop a hill overlooking Lake Mendota. "No better site could have been selected, situated as it is in the midst of a green plain, and protected on all sides from encroachments."

The announcement of the "munificent gift" of a large 15-inch telescope to the University of Wisconsin apparently aroused con-

* Paper read at the 89th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

siderable interest in astronomy in the backward Middle West. American astronomy before that date (1877) was limited to small telescopes mostly in the east. The largest telescopes in the United States were a 15-inch telescope at Harvard, an 18-inch telescope in Evanston, and a 26-inch telescope in Washington.

The telescope given to the University of Wisconsin by Governor Washburn, built by the Clark Brothers of Cambridge, Massachusetts, was an excellent instrument. The specifications stated that the large telescope should be equal to or superior to the telescope at the Harvard College Observatory. This was not rivalry, but lack of terminology for describing the requirements. The final size of the objective lens was 15.6 inches, thus making it the third largest telescope in the country. Construction of the building to house the telescope began in May, 1878.

It was only natural for the still young university to attempt to obtain the services of a well-known astronomer. Professor James C. Watson of the University of Michigan was noted as a discoverer of asteroids and as a writer in the field of mathematical astronomy. The attraction of a superior telescope lured him away from his position in the department of astronomy at the University of Michigan, and he accepted the position of first director of the new Washburn Observatory.

Professor Watson took office immediately (October, 1878) and was chiefly occupied with completing the main building, perfecting the interior arrangements, and starting astronomical work. At his suggestion, a wing was added to the original building almost immediately. This wing is on the east end of the original building and was used for the office of the director and the astronomical library, a gift from Cyrus Woodman, a friend of Governor Washburn.

At his own expense, Professor Watson started to build a Students' Observatory to free the major equipment for research, and a Solar Observatory on the hill south of the main building. The Students' Observatory contained a small transit instrument for the determination of time and latitude primarily, and a 6-inch telescope which had belonged to Mr. Burnham, who was an expert double star observer. Mr. Burnham was a Chicago court reporter, who came to Madison on week-ends (and later to the Yerkes Observatory in Williams Bay) to measure his stars. The Solar Observatory was to be used with a moving mirror set up on top of the hill to direct the light from the sun down a tunnel parallel to the axis of the earth. It was also to be used to rediscover a planet Watson thought he had discovered. This planet was the so-called "Vulcan" between Mercury and the sun. The observatory was unsuccessful; the planet does not exist. The building was used for many years as a storeroom. Finally it was about ready to fall apart, and as a uni-

versity crew was starting to tear it down, it was set on fire and burned.

Unfortunately Professor Watson did not live to see the fulfillment of his plans. He died a little more than two years after entering his new position while engaged in superintending the completion of the observatory.

One of the conditions of the gift of Governor Washburn was that the public should be permitted to see the heavenly bodies through the large telescope. Accordingly the first and third Wednesdays of every month were set aside for visitors and all were welcome to see the moon, some planet, or other object of interest, when the weather permitted. These open nights are still well attended after eighty years, the attendance during the summer months frequently passing the 100 mark. The all-time record was set in 1954 when Mars was in favorable position for observation.

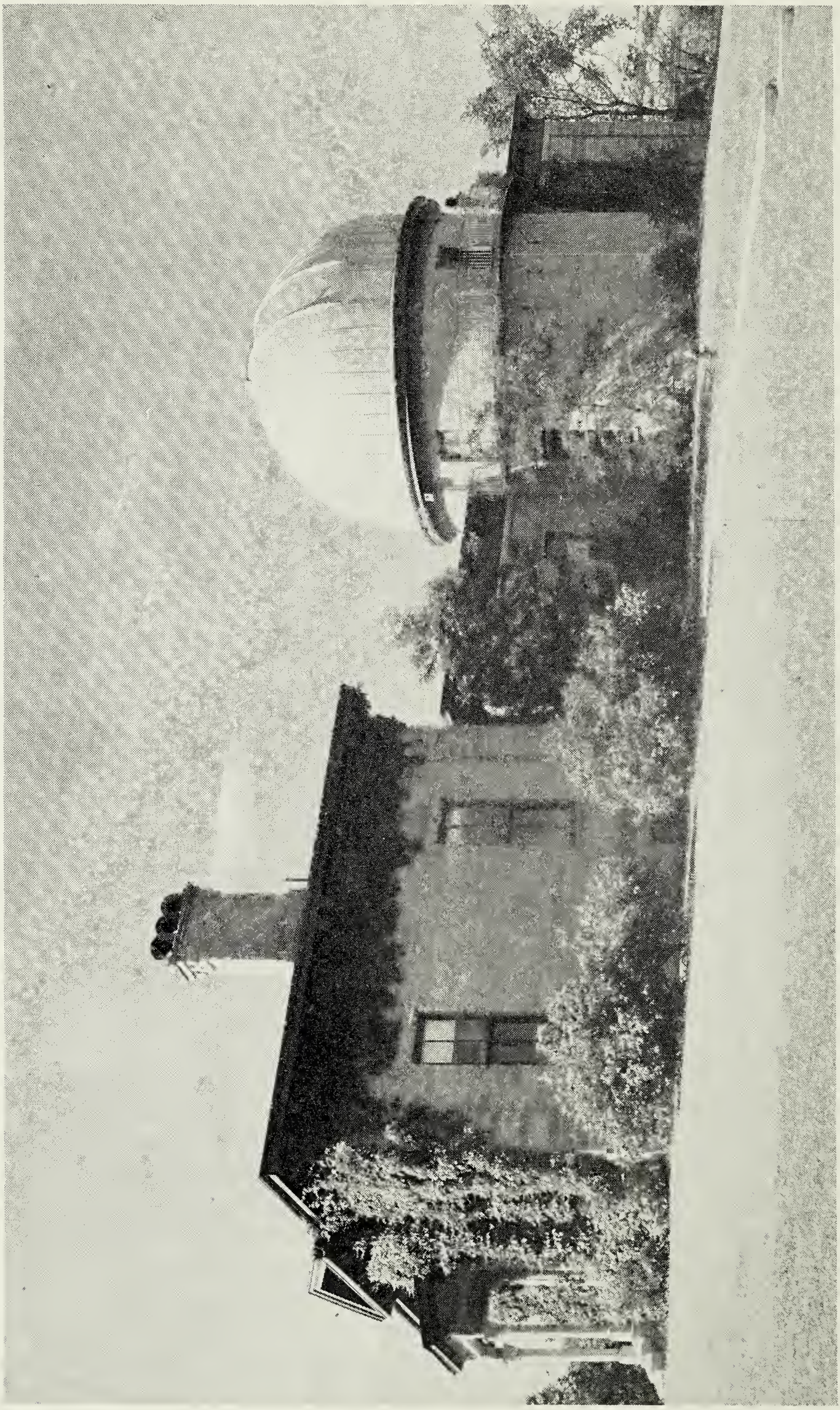
Alexander Graham Bell was a personal friend of Watson's and provided two telephones. They were set up between the observatory and Science Hall so that Watson could call his mechanic easily. The first commercial phones in Madison were not installed for two more years.

An observatory was a very important addition to the educational institution because it was thought at that time that a college could not become a university without one and Wisconsin citizens and officials thought an observatory would be an indication of sophisticated education. When the Washburn Observatory was finished, the University of Wisconsin was complete, and Wisconsin had become thoroughly civilized. (It is interesting to note that in 1954 when President Elvehjem, then Dean of the Graduate School, asked the Alumni Research Foundation for funds to build a new observatory in the country, he said a modern observatory was needed to continue research in astronomical studies of the universe.)

The new wing was finished in 1881. The original equipment included the 15.6-inch telescope housed in the large dome in the first unit of the building, a meridian circle in the west wing where the class-room is now, and three accurate clocks. One of these clocks has always been used to keep sidereal time (star time) and the other two for standard time, since time was sent out by wire to the railroads of the region before the days of Western Union.

The 15.6-inch refracting telescope has a focal length of 243 inches (20′ 3″) and the objective is the usual achromatic visual arrangement of two lenses separated by 1.78 inches. Its auxiliary equipment includes a micrometer for measuring distance and angles between components of a double star.

For more than 40 years after its erection, the 15-inch Clark refractor was used for visual observations, mainly of double stars,



Washburn Observatory.

with the filar micrometer. Double star measures were made by Professor G. C. Comstock, who was the third director (1889–1922), and by Mr. S. W. Burnham (mentioned above) who was observer for a short time. Many new double stars were discovered with Burnham's famous six-inch telescope, which was still set up in Madison until two or three years ago, and the large 15-inch telescope. The six-inch telescope was replaced by a more modern 12-inch Cassegrain reflector on the same mounting. This mounting was not the one originally used, but was a new mounting built about 1930 in the university shops as experimental for remounting the 15-inch. Burnham's telescope has been on loan to a young astronomer in Appleton, but will soon return to Madison, and after being remounted will occupy one of the two new domes on the roof of the new addition to Sterling Hall.

The 15-inch telescope was remounted about 1932 on a modern mounting designed after the type made by the Warner and Swasey Company of Cleveland, Ohio. The new mountings for both telescopes were constructed by Mr. Mel Kidder in the shops of the engineering department. It is expected that the telescope and its mounting and equipment will be sold this summer after 81 years of useful work. The money from the sale will be used to buy a new 16-inch reflecting telescope for the Department of Astronomy.

Professor Comstock became very well known in American astronomy. His university duties included teaching classes in descriptive and practical astronomy; and during his later years, he was Dean of the Graduate School of the University. He served many years as Secretary of the American Astronomical Society and was President of that society for a term of three years.

Another well-known work done at the Washburn Observatory was that with the meridian circle—a 5-inch instrument from Germany. With this instrument, Mr. A. S. Flint measured minute changes in the positions of stars caused by the motion of the earth around the sun. These measures permitted the computation of the rate of change of position of a star—its so-called "proper motion" and also its parallax. From the stellar parallax it is possible to compute the distance of the star. The work of Professor Flint might be considered as pioneer work in the determination of stellar distances, since he was one of the first to make systematic determinations with sufficient accuracy. His work was later surpassed in accuracy with the building of larger and longer telescopes. Many of Mr. Flint's measures are still useful in accurate determinations of stellar motions. His last measures were reduced and published in 1939—sixteen years after the death of the observer.

In 1922 an abrupt change in the work of the observatory took place. The older program of visual observations was replaced by a

branch of modern astrophysics—that of photoelectric photometry. The photoelectric effect had long been known and had been applied to astronomy some time before in Germany. The pioneers in the United States in this field of astronomy were Stebbins and Kunz at the University of Illinois. Jacob Kunz was professor of physics; Joel Stebbins was professor of astronomy. Together they made photocells and tested them on the telescope. Success was first attained about 1916.

When Director Comstock and Professor Flint reached the age of retirement, the University of Wisconsin again went to a sister university and called one of her professors to be director of the Washburn Observatory. This time Professor Stebbins came to Madison and became the fourth director of the Washburn Observatory. He was lured away from Illinois by the clearer skies of Wisconsin and the location of the observatory with a lake to the north which was to be a protection from encroachment and the smoke of industry.

The observational photoelectric work was transferred from Illinois to Wisconsin, with Professor Kunz remaining behind to make the photocells in the laboratories in Urbana. One of the authors of this paper (C. M. Huffer) came at the same time as an assistant in astronomy with the privilege of working for the degree of Doctor of Philosophy.

The association of Stebbins and Kunz was maintained even though they belonged to separate institutions. The photocells made by Kunz were important parts of the apparatus used at the University of Wisconsin. No better cells of that type have ever been made. Kunz cells were still used in Madison up to Warld War II, although many commercial and special cells by wellknown firms had been tried. It was always hoped that an especially successful one would be found. The Kunz cells had their maximum sensitivity in the blue region of the spectrum. They were strongly color-blind. A photocell sensitive to the red would have been a big help and would have extended the work in a very much to be desired direction.

The application of the photocell to astronomy consists in illuminating the cell with star-light and then measuring the photoelectric current which is produced when the molecules of potassium or other metal in the sensitive cell are bombarded by quanta of energy from the stars. If two stars are equal in brightness, the current produced is equal in the two cases. If one star is brighter than the other, it gives more current. The amount of current is strictly proportional to the amount of incident light. Hence this method is very useful in comparing the brightness of the stars and in computing how much brighter one star is than another.

Suppose a star, the star Algol in the constellation Perseus for example, is known to vary in brightness and that it is desirable to know the law of variation. A nearby comparison star is chosen whose brightness can be shown to be constant and the variable star is compared at frequent intervals with the chosen standard. In this way the light-curve of the variable star can be plotted and studied. If the variable star is an eclipsing binary—that is, if the variations are caused by the eclipse of one body by another in a double system,—then the size, mass, and density of the two stars of the system can be determined. This requires in addition observations made with the spectograph at some other observatory, but the light variation is essential for the completion of the solution. Measures of brightness made with the photo-electric photometer are more accurate than measures made with any other means and yield the most satisfactory solutions of the problem.

The main work of the Washburn Observatory beginning in 1922 was with eclipsing variable stars, although the development of the apparatus was by no means neglected. Several new eclipsing binaries were discovered and studies carried through for the determination of size, mass, and density. Others discovered elsewhere were observed in order that the accuracy of solution might be improved. Variable stars of other classes were also studied. These stars included stars of the Cepheid class and several new discoveries were added to the lists. A systematic survey of red stars of class M added about sixty new variables. These stars vary irregularly and no attempt was made to carry the problem further than the discovery and proof that most stars of this class are variable.

Beginning about 1930 the measurement of stellar colors was added to the program of observation with the photocell. By the use of colored filters, it was possible to compare the colors of stars and to set up a system of standards by means of which the color of a star may be described. In particular, the colors of blue-white stars (class O and B stars) were compared with each other. The spectra of these stars are nearly alike and the temperatures indicate that they should all be the same color. This was found to be true for all stars of this class outside the Milky Way. Inside the Milky Way, however, stars showing the same spectrum were found to be redder than those outside, except for the brighter stars which are known to be closer than the fainter ones. The interpretation of this difference is that the reddened stars are inside or behind a cloud of gas or dust which not only absorbs the blue light more strongly than the red, but decreases the total light of the star. The effect is the same as the reddening of the sun when it nears the horizon except that in the case of the stars, this reddening effect is produced by a cloud in the Milky Way and at stellar distances from the sun. Hence

this study of the colors of stars of class B makes it possible to detect the location of these dust clouds among the stars and in some cases to determine their distances from the sun.

The study of the colors of stars made in Madison has been supplemented by similar studies of globular clusters and galaxies observed at the Mount Wilson Observatory with photo-electric apparatus made at the Washburn Observatory. The net result of all these studies has been that the diameter of the Milky Way system has been reduced from 200,000 to less than 100,000 light-years, which is in agreement with the results obtained by studies of the rotation of the system made with the spectrograph. These color studies were extended to include distant stars of other spectral classes with the hope that a better knowledge might be obtained of the location, size, and distance of the galactic interstellar clouds and the possible detection of a cloud of dust around the sun itself.

The development of photoelectric apparatus is also a necessary part of photometric research. Since the current produced by the photocell is very small, very sensitive instruments of measurement are necessary. At the beginning of the photoelectric work at the Washburn Observatory, an electrometer of very cumbersome type was used to measure the photoelectric current. This instrument made use of the change of position of a very fine wire placed in an electric field. As the wire was charged by the current from the photocell, its change of position was read with a microscope and the current was measured by the rate at which the wire was seen to move in the field of the microscope. This first electrometer was later replaced by a smaller one produced by the Cambridge Instrument Company. It had an advantage over the older one because it could be used in any position, which was a decided help, since it was used on the moving eye-end of a telescope.

It was not until 1932 that a major improvement was made in the method of measurement of these small currents. That year it became possible to amplify the photo-current by means of a vacuum tube. This was accomplished by A. E. Whitford, then a graduate student in physics. Amplification was possible because of the development of special vacuum tubes which could be operated from storage batteries which give a very steady current. The circuit was devised by physicists at other universities, but was successful for astronomical observations when Whitford got the idea of placing photocell and vacuum tube in a tank from which the air could be pumped. This partial vacuum got rid of disturbances due to cosmic rays and stray charges which were troublesome because they were nearly as large as the current to be measured. The advantage of amplification over the older methods of measurement was that it now became possible to measure smaller currents and therefore to

observe much fainter stars. This new photometer was as accurate as the old one for bright stars. The new technique opened up a much larger field of study since there were many more faint stars available for study. So this method was used satisfactorily for several years and was copied at other observatories.

Two further improvements in photoelectric techniques should be mentioned. During the war a new type of receiver was perfected. This new tube produced a current of electrons when exposed to light as usual. But it also replaced the complicated amplifier which had been used before and multiplied its own current by means of a series of plates inside the tube. The amplification factor was of the order of one million times. This tube is called the 1P21.

Also it became possible to record the amplified photoelectric current automatically. The first recorder was the Esterline-Angus recorder. A strip of paper was moved automatically and a pen made a tracing on the paper. The deflection of the pen measured the current and therefore the brightness of the light. This tracing could then be read later. Before its use, it had been necessary to record the rate of charge of an electrometer or to read the scale of a galvanometer. This old arrangement required two people—one to run the telescope and photometer, the other to read the scale. With automatic recording, a single person could operate the installation and read the record at his leisure. The Esterline-Angus suffered from uncertainties because of the drag of the pen. So it was replaced by a better recorder, the Brown Recorder, which is still in use.

The use of the 1P21 multiplier tube and the Brown recorder required an amplifier in addition. These amplifiers were usually made in the shops of the Washburn Observatory, although a commercially made amplifier is now available and in use. The 1P21 multiplier works better if refrigerated with dry ice. This means that it is necessary to keep a supply of dry ice on hand and grind it to a size small enough to put inside a cold box around the multiplier tube. This is now standard practice.

In 1948 Professor Stebbins was retired and Dr. Whitford replaced him as director. Whitford had been active in the perfection of photometers and had spent several months of each year at the Mt. Wilson Observatory. He and Stebbins had collaborated for many years on the photometry of stars and had developed six-color photometry which was successfully used on the large telescopes. They also applied their techniques to observations of the globular star clusters and to the galactic systems in reach of the 100″ telescope.

In 1954, the Alumni Research Foundation granted $200,000 to the Department of Astronomy for the building of a new observa-

tory. This grant was obtained through the help of Dr. Elvehjem, as mentioned earlier in this paper. The Alumni Research Foundation had some years before granted the research committee of the University funds sufficient for the optics of a 36″ telescope. The two mirrors had been purchased from the Corning Glass Works and had been figured in the shops of the Yerkes Observatory. The new grant provided for the building of the telescope and the erection of the building, which was completed in 1958 and dedicated at a meeting of the American Astronomical Society. The new observatory is located about two miles north-west of the village of Pine Bluff, and is 15 miles west of Madison.

The new telescope is the latest word in modern design. It is a Cassegrain reflecting telescope and has electronic controls operated from a control panel or by a control paddle at the eye end of the telescope. Photoelectric observations in three colors have been under way since the summer of 1958, and later that year a spectograph of modern design was installed and tested.

On July 1, 1958, Dr. Whitford left the University to go as director to the Lick Observatory. He was the second director of that observatory to be selected from the staff of the Washburn Observatory, Dr. Holden was the other one. Dr. Arthur D. Code, who had formerly been a staff member of the Washburn Observatory, was selected as director and came to assume the duties as director in September, 1958. Dr. Donald E. Osterbrock came also as a new addition with the rank of Assistant Professor. Dr. Theodore E. Houck was retained as instructor and Dr. Robert Bless came as project associate to work on the spectograph, which has a photoelectric scanning device, replacing the usual photographic plate. Work on this program has been delayed because of severe weather conditions during the winter and spring of 1959.

Then at about the same time as the planning and building of the Pine Bluff Observatory, the Wisconsin Alumni asked for the old building on observatory hill. The astronomy department consented, provided that suitable quarters could be found on the campus. Plans for building a wing on Sterling Hall were being made and it was decided to give the sixth floor and roof to the department of astronomy. The wing was finished and moving started in March, 1959.

The Washburn Observatory is and always has been a link in the chain of astronomical research. Beginning with the study of double stars and the pioneer measures of stellar parallax, through the color observations for the determination of the size of the Milky Way system, to the present work on various studies in the field of astronomy, its work has been one of cooperation with other observatories. The observations made in Madison are published in the

Publications of the Washburn Observatory and in various other astronomical journals. We depend on other observatories for observations with the spectograph and other physical instruments and frequently hand on our observations for the help of some one engaged in other problems of research. Present knowledge of the physical nature of the universe cannot be the result of the work of a single individual or institution but must be done by cooperation and the willingness to give the other fellow the benefit of experience and results from the special field which any one observatory undertakes.

With the moving of the department to another building, a long phase of astronomical work at the Washburn Observatory of the University of Wisconsin is ended. It is difficult to give up the beautiful view of Lake Mendota and all the associations and memories of Observatory Hill. But in the interest of improvement and an expansion into the modern field of astrophysics, the move seems very satisfactory. It is gratifying to see that astronomy today is even more interesting than ever before and even essential to modern civilization—whether for better or worse remains to be seen. As the work of the old Washburn Observatory has been prominent in astronomical circles for 81 years, it is to be hoped and expected that the work of the new department will lead in coming astronomical developments. It would have been impossible in 1878 to foresee the change from visual to electrical astronomy. We are just as unable to foretell what future developments in astronomy will bring. If space travel is to be the most important study of the next few years, plans at Wisconsin will be and are being made to cooperate and experiment in the new field. We wish our successors well and have every reason to expect great things in astronomy in Wisconsin in the future.

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